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IS PARASITOLOGY A SCIENCE?*

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Some years ago I was told that a distinguished entomologist had expressed the opinion that parasitology is not a science. There were no reasons accompanying the statement and, after a brief wondering about it, I forgot it for a time. Within the past year a similar statement was brought to my attention as emanating from some colleagues who might be called parasitologists if they had no objections to the name. This recrudescence of unbelief in the validity of parasitology as a science moves me to come forward at this time and make certain comments on parasitology, science, scientists and related subjects. Some of the things I have to say seem to me self-evident, but if they are self-evident, they are not said often enough or appreciated sufficiently, or we should hear fewer comments such as this one suggesting that parasitology is either outside the city limits of science, or at best is one of the slum sections down by the railroad track.

As a preliminary to this discussion let me place this comment on parasitology in a section which I reserve for somewhat similar comments and remarks by scientists, which have come to my attention in the past quarter century. From various biologists: Psychology is not a science. From a distinguished physicist: Economics is not a science. From sundry zoologists: Medicine is hopelessly unscientific. From experimental biologists: Taxonomy as a science amounts to nothing. From all sorts of scientists: This or that scientific fact is not important. I propose to leave parasitology for the moment, alongside of psychology, economics, medicine, and taxonomy, as one of the subjects which scientists have declared not to be sciences, in association with the statements that certain scientific facts are unimportant. Meanwhile, let us clear the ground for discussion.

Speaking formalistically and by the book, the book in question being the dictionary, science is classified knowledge, in these or similar words. As usual, the dictionary proves to be an uninspired and overrated book,

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running to inadequate definition as noticeably as it does to lack of plot and dialogue. Even as a study in denotation, this definition of science is incompetent, since it ignores the fact that scientists, as opposed to teachers of science, usually mean by science the business of research, the hunt for new facts, and the derivation of new principles. From the standpoint of connotation, one may excuse the dictionary for failure to mention that science is, variously, an affair of sound methodology, a matter of securing valid data and deriving sound conclusions from these data, the application of these conclusions to the solution of new problems, and something involving a frame of mind characterized by an effort to attain intellectual keenness, honesty and courage in a search for facts, truth and reality.

Abandoning the dictionary, I proceed to lay down my first thesis as follows: Any or all of the facts in Nature, including among these facts the vagaries of human mentality and conduct, may be investigated in a scientific spirit and manner, with results expressed in sound data and valid conclusions, and when so investigated, and the findings systematically arranged, the result is a science. From a purely scientific point of view, disregarding the individual's scientific interests, or the question as to how far a science has been developed, a science of coprology or skatology is, at least potentially, as much of a science as mathematics, astronomy, physics, chemistry, biology, economics, or any other subject recognized by its investigators as a science.

My second thesis is as follows: From a strictly scientific standpoint, any one science is potentially, regardless of its present stage of development, as important as any other science, and any one scientific fact is as important as any other fact. I shall adduce little positive argument in support of this thesis, but I urge on your attention the lack of evidence to the contrary. In our loose and causal manner of speaking, we refer to this or that piece of scientific work as important or unimportant. In what balance do we weigh these works to ascertain their importance? What do we mean by importance?

If by important we mean important in human affairs, we are talking of economic, social or medical importance, but not of scientific importance. Babcock's application of the affinity of water and sulphuric acid to milk testing is of great economic importance, but, in the field of science, that application is simply a scientific fact alongside of other scientific facts.

If by important we mean that one fact is important because it is immediately fertile in leading to new findings, we may well note that many facts are known to have lain dormant for years before they were put to work in the search for new facts, and have then been very productive. Facts used as tools with which to dig up new facts are, for

the moment, important as tools, subject to the possibility that better tools will supplement or supplant them.

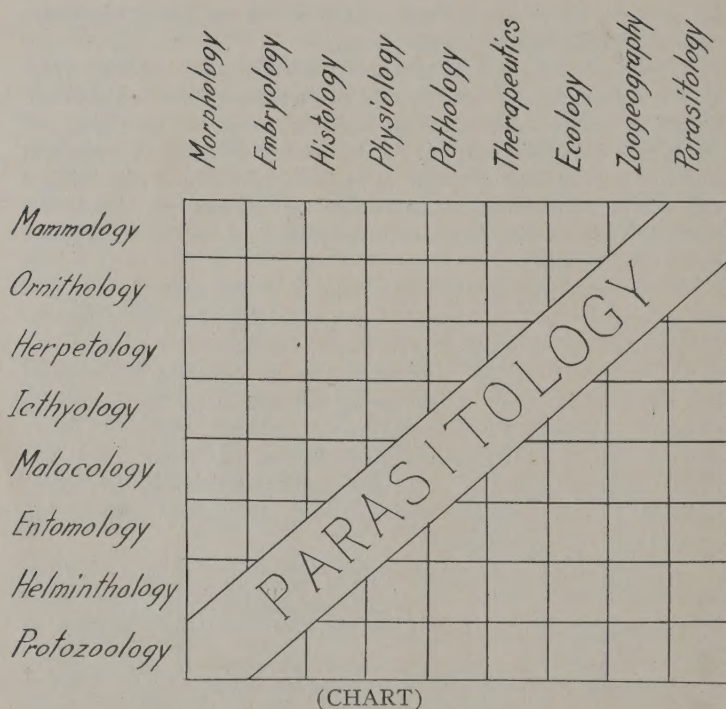
If by important we mean that one fact is easily and quickly arrived at, and another is not, then we may be comparing lilies and oaks, although an oak is no more and no less a scientific fact than a lily, or our fallible mentalities may not see the quick solution of what seems at first the more difficult problem. Physicists contend that the brilliant and difficult experimental demonstration of the speed of light is less valid than the solution based on a correlation of various facts established in other ways.

If by important we mean important to us personally in our own work, let us say so. If, when we speak of a piece of scientific work as unimportant we mean that it is incomplete, unsound or inadequate, let us say so, but let us look with skepticism on comments to the effect that any scientific work is unimportant because its content doesn't interest us or appeal to us. So far as we can see, all facts of Nature dovetail with all other facts in their space-time continuum, and if this is true we may subscribe to the philosophical conclusion that as inseparable parts of a unified whole, all facts are alike scientifically important and equally important.

The delineation of a field of science arises from a point of view fixing a specialized interest, and the selection for study of the facts centering around this interest. This may be illustrated diagrammatically as shown in the chart.

If we take the broad field of zoology, and divide it on the basis of taxonomy, using the standpoint of classification as our arbitrary scheme of division, and confining our interest to the facts centering about a certain group of animals, we have such sciences as those ranging from protozoology through mammology which are illustrated in the diagram. Now if we ignore taxonomy, and take structure, function, relations, etc., as standpoints from which to divide the field of zoology, we have such sciences as those listed from morphology through ecology. Persons who believe that protozoology and entomology are sciences, but physiology and ecology are not, or *vice versa*, apparently are persons who believe that horizontal lines are more important than vertical lines, or that the reverse of this is true.

In this diagram the field of zoology is divided into a set of squares by the intersection of the lines dividing the field horizontally and vertically. In each square we find the fields of common interest to two sciences, such as the morphology of mammals, embryology of birds, histology of reptiles, physiology of fish, pathology of mollusks, therapeutics of insects, ecology of helminths, etc. Some of these squares



(CHART)

may not in fact be represented by existing sciences, and may never be; it is immaterial.

The point of view which establishes the science of parasitology is an interest in parasitism. To represent parasitology we may draw an oblique field ranging all the major fields formed by horizontal and vertical lines, or, as an alternative, may put it in as a vertical group parallel to physiology or pathology.

An immediate observation following from the oblique position of parasitology in the diagram is to the effect that if one takes parasitism as one's object of special interest, the resulting field of science overlaps sectors of many other fields of science. This is not news, and all parasitologists know it. As parasites or hosts, practically the entire animal kingdom falls within the purview of the parasitologist, which is one reason why the parasitologist should be first of all a zoologist. But since parasitology is medical zoology, various fields of medicine, usually, but not necessarily, regarded as outside the field of zoology, also fall within the purview of parasitology.

I feel that the criticism of parasitology as a science of little merit probably has part of its origin, consciously or unconsciously, in an objection to the wide extent of parasitology and its variety of interests. If so, are the size of the field and the variety of its topics sound objections to the science of parasitology? Do its size and variegated characters imply that such a field cannot be covered, or that in attempting to cover some or all of it, parasitologists are necessarily superficial or incompetent?

A not too satisfactory division of science as a whole is one which divides it into exact sciences and inexact sciences. Exact sciences are sciences of measurement, characterized by reasonably attainable precision in measurement in mathematical terms; such sciences deal with things capable of measurement by known methods. The inexact sciences are those in which such precise mathematical measurement is not possible at present for lack of known methods of measurement.

Mathematics has been called the "queen of the sciences." It is a peculiar and special science dealing primarily with the properties of numbers. In dealing with those properties which Nature has incorporated in numbers, the mathematician restricts his personal combat with Nature to a field in which he is relatively free from materiality and from the "deuces wild," "jokers," and "aces up the sleeve" with which Nature bedevils other scientists. The mathematician can, to some extent, formulate his own rules. So specialized is the nature of mathematics, and of its sister, music, that certain children and certain feeble-minded persons share with geniuses an exceptional ability in dealing with numbers. In saying this I am not confusing the uncanny ability of an ignorant negro to extract a cube root without knowing how he does it with the mathematical ability of an Einstein, but I would note that certain mathematical abilities have an inherent character relating them to such things as the nursing instinct. Yet I concede without argument that mathematics is as much of a science as parasitology.

When we leave the pure science of mathematics and enter the field of the physical sciences, we begin to deal with the properties of matter and force. Here our speculations and reasoning can be given objective test, and the theoretical must be adjusted to the pragmatic and the real. The subject-matter is to this extent less simple than pure mathematics, but is still not complicated by many of the novelties of biology. Physics and chemistry can approximate mathematical precision in their procedures, but must pursue a fact-finding process of a sort not comprehended in mathematics *per se*, as part of their procedures. These physical sciences thus share more of the characters of parasitology, and they, too, are as important as parasitology.

When we enter the field of the biological sciences, we encounter new phenomena pertaining to the special character of life, and among these special characters we find the special peculiarities associated with the nervous system, notably the mental processes. Measurement and mathematical manipulation become increasingly difficult. Such simplicities as counting, measuring and weighing become increasingly inapplicable. Measurement calls for entirely novel methods and non-existent apparatus, and in default of such methods and apparatus for certain things, these sciences must concern themselves to a larger extent with fact-finding of other sorts and to the elaboration of somewhat different theories and principles. In other words, the field which the scientist now explores in seeking to satisfy the unquenchable scientific curiosity which characterizes all scientists, is more complicated, certain new difficulties are introduced, and certain methods useful in mathematics and the physical sciences are inapplicable or fail to give results as satisfactorily or dependably as in other fields. Shall we say that biological sciences are inferior to physical sciences because they deal with materials and forms to which the physicist cannot apply his methods and apparatus, or because the chemist cannot ascertain the chemical formula of protoplasm?

In brief, the differences in subject-matter in different sciences call for somewhat different technics, and some of the methods applicable in one science may or may not be applicable in another. But while we are on sound ground in saying that sciences differ, we are not on sound ground in saying that one is better or more important than another. The second law of thermodynamics is no more and no less important, scientifically, than the Mendelian law. The *pons asinorum* has no more importance, scientifically, than the scientific demonstration of the transmission of piroplasmosis by *Boophilus annuatus*. The discovery of a new star is no more important, scientifically, than the discovery of a new tapeworm.

If those contentions are not true, what evidence have we that they are not true? One thing may be regarded as more important than another on either a quantitative or a qualitative basis. If scientific work is to be judged as important or unimportant on a quantitative basis, how are we to proceed to judge this quantity? Shall we regard astronomy as the most important science and the study of electrons as the least important? Preposterous! It is possible, and even probable, that if the realities now appertaining to electrons ceased to be realities, the shock would more or less disintegrate the universe. On a qualitative basis, what constitutes importance? I see no answer to such a question.

I am suspicious that when scientists speak of any science as un-

important, they are unconsciously accepting a homocentric concept of the universe, which science has formally and properly rejected. Homocentric concepts are important to *Homo*, but not to science. I suspect that one science, for some reason, is important to these scientists as individual representatives of *Homo*, rather than that one science is scientifically important among sciences. To all such points of view regarding any science or fact as unimportant, I take exception on the ground that such points of view are probably personal prejudices remote from the declared objective of science in the search for fact, truth and reality.

But perhaps, as I have noted, the critics of parasitology as a science feel that with so wide a field to cultivate, the parasitologist must fail to delve deep. Admittedly, one can delve deeper, all other things being equal, over a smaller area than over a larger one. But this is as true of other sciences as of parasitology. The scientist may restrict his activities to a limited field or to a problem in his science, or may attempt to cover a wider range; the results obtained will differ more or less along the lines of intensity *versus* extensiveness.

Perhaps it is thought that parasitology has been unproductive of great scientists. But surely such men as Leuckart need no apology in comparison with outstanding zoologists. Does it matter whether Goldschmidt, Boveri, and zur Strassen worked on the cytology of ascarid eggs in the capacity of cytologists or parasitologists? They were in the overlapping fields of cytology and parasitology in any case. Was the discovery that *Leptocephalus* is the larva of an eel more important than the discovery that *Cysticercus cellulosae* is the larva of *Taenia solium*?

I do not go further into this aspect of the argument for the reason that if parasitology had never developed a scientist of the first or second magnitude, it would not constitute an argument against the scientific importance of parasitology. One scientist, by virtue of ability or productivity, may be more important as a scientist than another, but while it requires scientists to make the potentialities of a science realized, the importance of a science is independent of its votaries. The scientific importance of a science may be largely a potential and unrealized importance. Nature's laws operate regardless of human knowledge of these laws, and their importance is independent of the status of our knowledge regarding them. Geometry was as important before Euclid as it has been since Euclid, and the law of gravity was as important as a working reality before it was formulated as it has been subsequently.

In making statements to the effect that any specified sciences or scientific facts are unimportant, as many of us habitually do, we are

guilty of being unscientific. True science is dispassionate, impersonal, and devoid of emotional bias. To the extent that it is all of these things, it is an ideal for which we may strive and which we may approximate, but which we cannot wholly attain. The human animal is decidedly not dispassionate, impersonal or devoid of emotional bias, and scientists are human animals. What we are trying to achieve in a search for objective truth is a novelty in human life, and the experience is still too novel to permit of attaining any considerable degree of success in the attempt. We are under the serious handicap of having no better material than human beings from which to make scientists.

How sadly we fail in our attempts to make scientists of human beings is only too evident. We do not achieve the impersonal. We allow our personal prejudices to enter into our estimate of science and scientific facts. We take our emotions into our laboratories, write them into our scientific papers, and weigh them in with our appraisals of our scientific colleagues.

Within the confines of our laboratories, however, we do achieve a slight measure of success in this new business of trying to ascertain facts, which we are substituting for the old business of trying to justify our faith or prove our prematurely preconceived theories. As we stumble along new paths and bark our shins on our mistakes, we gradually learn that we must explore many blind side roads and that we shall reach no mountain tops; we come to see our rôle as that of pioneers who more or less clumsily blaze a few feet along a trail to a realization of reality that man will never attain.

In conclusion let us retrace our steps. If any one science is as important scientifically as any other science, and if any one scientific fact is as important scientifically as any other scientific fact, both of which ideas seem incapable of disproof on any quantitative or qualitative concept of importance, let us cease to cavil about the sciences and facts that do not interest us as individuals, and let us leave our emotional bias out of our scientific work. Let us get our feet on the ground and realize that as scientists we should cultivate the scientific mind and method, and use that mind and that method in our attitude toward our colleagues, toward scientists in general, toward science in general, and toward life. No scientist ever approximates too closely our ideal of a scientist, since all scientists labor under the handicap of being human beings, with all that implies in the way of emotions, prejudices and childhood fixations. No science approximates too closely the ideal of a science in its approach to exactness, fact, reality, and ultimate things. Nevertheless scientists are conspicuously the group which searches for fact and reality, and we can employ our time better in that search than in idle comments about the unimportance of

sciences and facts. In the immense field of science, parasitology has its place. It has certain tasks which other sciences do not undertake. Parasitology needs no apology. If parasitologists need any it is not because of their science but because of their individual failures. On the whole I see no reason for apologizing for parasitologists that does not involve apologizing for the entire human race.

TWO NEW HELMINTHS FROM *RHINOCEROS SONDAICUS*

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Of the three species of *Rhinoceros* extant in Asia, the lesser one-horned *R. sondaicus* appears to be by far the rarest. In the immediate past the species was known in the Sunderbans of Bengal, in Burma, the Malay Peninsula and some of the mountainous islands of the East Indies, but to such an extent have its numbers been reduced that the species is now considered very rare. A small herd of unknown size is being jealously conserved in the islands of the Dutch East Indies, in which country alone is it still definitely known to persist. Among the few specimens that are preserved in the museums of the world, the specimen in the Museum of Comparative Zoology is the only one in America. In the Malay States the species was thought to have become extinct, but a story, largely discredited by officials, persisted among the natives living on the edge of the bush in Lower Perak to the effect that an old cow of this species, presumably the mate of a specimen illicitly killed some ten years ago, still survived and at intervals various natives made claims of having seen the animal.

Commissioned, if possible, to secure this unique specimen for mounting in the British Museum of Natural History, Mr. Arthur S. Vernay, a celebrated naturalist and hunter of big game, fitted out an expedition to the region and in January, 1932, succeeded in locating and shooting the animal.

Before proceeding to the Malay States, Mr. Vernay had very graciously offered to save and preserve any of the "soft" parts of his prospective capture for members of the Museum of Comparative Zoology of Harvard University. Accordingly the writer prepared instructions to guide in the collection and fixation of parasitic worms. In due course we received the material upon which this report is based: several tubes containing admirably preserved cestodes and nematodes together with some interesting ticks which are to be reported on by my colleague, Dr. J. C. Bequaert.

Although the cestodes and nematodes both belong to well established genera, well known either from the same host or from related African species of *Rhinoceros*, the characters that have been used to distinguish the species in these genera are of debatable value, and I considered long before deciding to assign them to the independent specific status. In the absence of an extensive collection of comparative material from which conclusions may be drawn, one is compelled to assume the gen-

eral validity of the standards in vogue. On this basis both species described in this paper appear to be new. Brief discussions of the systematic positions are appended to each description.

NEMATODA

Family STRONGYLIDAE

Kiluluma vernayi spec. nov.

The material consists of nine specimens, of which three are males, taken from the large intestine. The worms are very much alike as to size and shape. The body is cylindrical, tapering gently anteriorly and posteriorly to abruptly rounded extremities. The cuticle is unusually thick and marked transversely by conspicuous, deep corrugations which tend to mask exceedingly fine superficial striae.

The head is set off from the main body of the worm by a narrow cuticular collar, the head emerging as from an ensheathing tube. There are six cephalic papillae—2 lateral and 4 submedian. Each of the four submedian papillae stand out prominently beyond the level of the mouth, and is made up of a cupola-shaped base from the summit of which there emerges, like a flagstaff, a narrow elongate process. The lateral papillae terminate in more typical fashion at the base of the mouth collar. The mouth (Fig. 1) is surrounded by the usual broad incurved lappets—

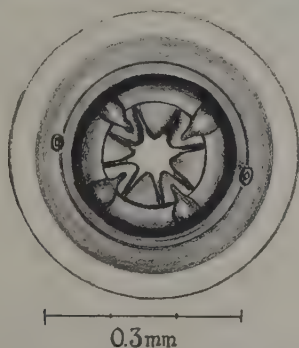


Figure 1. *Kiluluma vernayi*. End-on view of head.

eight in number. The buccal capsule is ring shaped—0.26 mm. broad and 0.07 mm. deep.

The claviform oesophagus is narrowest at the level of the nerve ring—0.36 mm. from the anterior extremity—and reaches a maximum breadth of 0.38 mm. near its middle. There is the usual terminal valve at the entry into the chyle intestine. In both male and female the length of the oesophagus ranges approximately from 0.95 mm. to 1.2 mm. The cervical papillae are elongate acicular structures that occupy posi-

tions either just in front of the oesophagial terminus or slightly posteriorad. Also at about this level is the aperture of the massive excretory tube.

The female body undergoes a very gradual diminution in its diameter towards the posterior end. This extremity ends very abruptly simulating a worm that has been subjected to a slightly oblique cut and producing in consequence a veritable posterior plane. On this posterior surface a small caudal extremity of the body stands out like a cone-shaped appendage; on this surface open the anal and vaginal apertures (Fig. 2). When a female specimen is mounted on its side (under



Figure 2. *Kiluluma vernayi*. Caudal extremity of female.

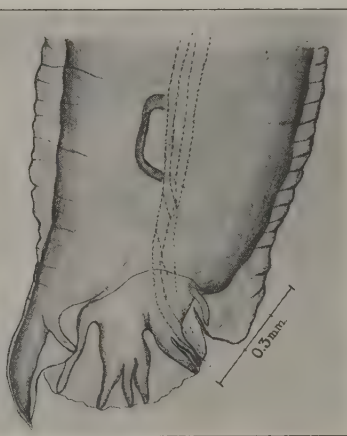


Figure 3. *Kiluluma vernayi*. Caudal extremity of male.

a certain amount of local pressure between slide and cover slip) the distance between the extremity of the body and the anus is 0.160 mm. and the vulva is situated about 0.1 mm. preanally. When the specimen is examined ventrally these distances appear fore-shortened. To some extent this will account for slight differences found in tail measurements of the other species that are described in the genus. The vagina, with slight variations, measures 0.95 mm. in length before dividing into two more or less intertwining branches that extend for a distance of 2.6 mm. before the ejaculatory swellings are reached.

The eggs in utero measure about 55μ by 70μ but these dimensions do not represent the size of the completely formed eggs that would pass from the body.

In the male the lobes of the caudal bursa and their supporting rays are in all major criteria characteristic of other species in the genus.

There is a well developed preventral ray which obviously represents merely a ventral prebursal papilla that has become elongated and shifted posteriorly. It has not, however, quite entered into the support of the lateral lobe of the bursa but is thrust out to the edge of the cuticle near the point of origin of the lateral bursal lobe. The extra lateral ray can plainly be seen arising from the common trunk which gives origin to the remaining lateral rays. The external dorsal (which itself shows no sign of forking) originates high up near the dorsal-ray root. The dorsal ray bifurcates at its extremity into two small branches.

The spicules are characteristically alate with proximal terminal knobs. They measure from 4.80 to 5.01 mm. in length in the three specimens and may be twisted when extruded.

The gubernaculum, while always detectable in the well cleared specimen, is very lightly chitinised and because of this condition its shape and size appear to be rather variable. In no instance could the gubernaculum be described as ring or horseshoe shaped even when viewed from the dorsal or ventral surface; rather was it in the form of a semilune with the posterior horn curved in the median direction and the anterior horn almost straight. There is, in one specimen, evidence of a secondary cuticularization of the cloacal wall which appears to be in contact with the gubernaculum. This telemon-like structure is, unfortunately, not sufficiently definite to warrant the stressing of size or shape. The characteristics of the posterior end of the male are shown in figure 3.

The very distinctive genus *Kiluluma* was created by Skrjabin for a number of Strongyles collected from *Rhinoceros bicornis* at Kiluluma in East Africa. The material described by Skrjabin as *Kiluluma stylosa* (von Linstow, 1909) was according to Thapar (1924) a composite of several species. As a device to avoid subsequent confusion, Thapar thought it desirable to allow the species *K. stylosa* to lapse, at any rate provisionally, and described the material collected by Professor Leiper from an East African *Rhinoceros* (*R. africanus*) as assignable to six different species. In a later paper written on the same collection of worms Thapar (1925) presented descriptions of what he believed to be four more new species of this genus.

Monnig (1926) working over material from *Rhinaster bicornis* from Zululand (South Africa) states that he found five of Thapar's original six species and described a new species, *K. longispiculata*, which having in the meantime been described in Thapar's second (1925) paper as *K. goodeyi* was consequently synonymised with the latter.

Yorke and Maplestone (1926) commented on Thapar's disposition of the genus *Kiluluma* with the following statement: "With the excep-

tion of *K. magna*, these species appear to us to be very similar to one another. We have examined a large collection of worms belonging to this genus obtained from five rhinoceroses, and although the individual worms were found to exhibit considerable variation we have been unable to satisfy ourselves that more than one species was present."

The difficulty of differentiating the majority of species of *Kiluluma* erected by Thapar is, as Yorke and Maplestone indicate, a very real one. With the possible exception of *K. magna*, which is slightly larger, and *K. goodeyi*, *K. brevivaginata* and perhaps *K. brevicauda*, in which the male may be distinguished by its longer spicules, the remaining species do not possess clear differential characters. The characters which Thapar regarded as distinctive of the species are not succinctly specified and only by a careful reading of the short accounts of the various species that he gives, can one glean the characters which appear to have prompted the separation of species. Many of these characters are really of trivial worth and even the size relationships of the different organs which might substantiate the differentiation of species are valueless because Thapar gives measurements from only a single specimen of each sex.

On one important item in the description of most species, concerning the number of plume-like lappets, comment is particularly necessary. Skrjabin (according to Neveu-Lemaire, 1924) originally described *K. stylosa* as possessing "quatre levres peripheriques (probably the saillant submedian papillae) et six levres internes." As Thapar observes: "in several respects Skrjabin's description is insufficient and his description of the mouth parts is particularly misleading." Thapar describes six fleshy lobes or "internal lips" (leaf-like elements of an internal corona) in *K. rhinocerotis* and the other species described in his first paper. In this author's second paper all the species, with the exception of *K. cylindrica*, are described as bearing 8 "lips" and in the diagram provided of the "end-on" view of the head this contention is confirmed. Monnig (1926) described six fleshy lobes arising from the buccal capsule of his *K. longispiculata* which he synonymised with *K. goodeyi* of Thapar. In *K. goodeyi*, however, the number of leaf elements sketched is eight. Yorke and Maplestone (1926) mention and sketch six elements in the leaf crown of the genotype, *K. stylosa*.

In the writer's material the examination of the toto-mounted specimens gave the impression of there being six leaf elements springing from the buccal cavity but the number could not be determined with any degree of certainty until the head was cut off. In the end-on view the leaf-crown is very definitely seen to be composed of eight elements. The question of the number of leaf elements does not appear to have been made a major consideration in the determination of species.

Thapar does not appear to have been particularly concerned with the question until his second paper was written, when in all instances he included an end-on sketch of the head which illustrates the point. Presumably there are species with six and other species with eight leaf elements, *K. vernayi* being among the latter. I take pleasure in naming this species in honor of its collector.

K. vernayi, so far as concerns the length of its spicules, bears greatest resemblance to *K. brevicauda* but it appears to differ most conspicuously from this species in the length of the vagina and its horns, in the shape of its gubernaculum and perhaps in the disposition or point of origin of the pre-ventral and extra-lateral rays.

CESTODA

ANOPLOCEPHALIDAE

Anoplocephala diminuta spec. nov.

Some twenty tapeworms with the characteristic structure of the genus *Anoplocephala* as defined by Baer (1927) and labelled as being taken from the small gut of *Rhinoceros sondaicus* were received in three percent formalin. As will be shown later, these specimens, despite their relatively small size, are structurally fully grown.

In the preserved state, the largest specimens, composed of from 20 to 25 segments, measure only from 10 to 12 mm. in length. The smallest specimens are about 7 mm. long. The scolex, which is blanché in contrast to the greyish yellow color of the segments, is usually partly covered or embedded in the concave border of the anterior part of the strobila and is slightly narrower in breadth (3.5 mm.) than these anterior segments. The scolices in other specimens are more overt with the aperture of the suckers opening conspicuously on the antero-lateral surfaces of the strobila. The suckers are about 1.2 mm. in outer diameter, their muscular walls being 0.4 mm. thick. Depending probably on the state of contraction, in some specimens the muscular parts of the scolex extend backwards as a mantle covering the middle sections on the dorsal and ventral surfaces of the first two or three narrow segments. This, however, does not produce the elongate lappeted appendages such as are described as characterizing *A. perfoliata* of the horse. The appearance of preserved specimens is shown in figure 4.

The individual segments of the strobila resemble a series of narrow elongate troughs set one within the other with their lateral margins, composed of the usual sub-cuticular muscle fibres extending in the dorso-ventral direction, two sets of longitudinal muscles aggregated in bundles of smaller fibres and a narrow band of transverse fibres that circumscribe the medullary parenchyma, overlapping about two-thirds of the surface of the segment following.



Figure 4. *Anoplocephala diminuta*.
Photograph $\times 3$.

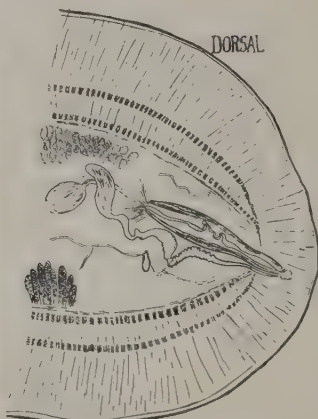


Figure 5. *Anoplocephala diminuta*.
Diagram of dextral side of mature
segment showing male and female

reproductive organs and system of excretory tubules. This figure is composite to the extent that at the stage where the vagina is patent the receptaculum seminis is not so large as in the above illustration nor are the ovarian follicles so well developed.

Especially towards the posterior end of the strobila, the overlapping horizontal edges of segments are frilled or scalloped. In a few specimens, where there is a more conspicuous scallop in the middle of the segments, more or less aligned, one behind the other, the appearance of a longitudinal furrow such as was pictured by Garrod (1887) is produced.

The greatest width attained by the segments is 9 mm. This width may be reached not more than 5 mm. from the scolex, behind which a gradual reduction in the width of the segments often occurs. The ultimate segments in the chain become very plump (2.5 mm. thick) and have a tendency to become separated at the margins from the chain; some are actually on the verge of complete separation.

As a result of the thickness of the specimens and the dense crowding of calcareous bodies in the cortical parenchyma, toto-mount specimens stained in the usual procedures to reveal the reproductive organs are very difficult to clear adequately with xylol or the essential oils. As an alternative to this, a method used by mammalian anatomists to demonstrate cartilaginous tissues in embryos was found eminently satisfactory (q.v. Miller, C. H., *Anatomical Record*, 1921, vol. 20, p. 415). Essentially the method consists of placing the washed specimens in 2%

KOH aq. for one or two hours and then transferring the specimens gradually to pure glycerin.

Owing to the relative weakness of the connecting tissues between the more mature segments, the latter can be pried apart by careful dissection with fine needles. When the segments thus isolated are individually mounted in series on their posterior surfaces, an ideal view is obtained of the gonads and their ducts in relation to the excretory vessels.

The structure of the mature segments is shown in figures 5 and 6.

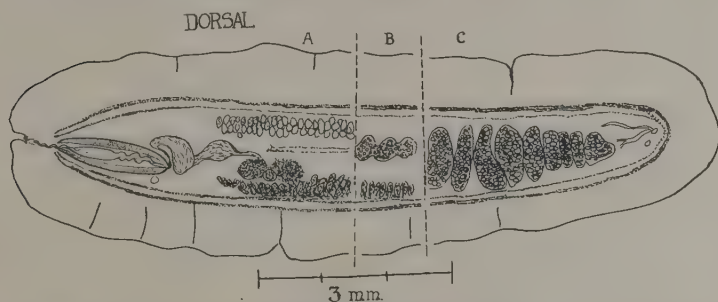


Figure 6. *Anoplocephala diminuta*. Compound diagram of a segment seen from its anterior face illustrating: A. Dextral side of segment after atrophy of vagina with male and female organs at height of functional maturity. B. Section of an older segment after disappearance of testicular follicles and with uterus in process of sacculization. C. Sinistral side of gravid segment with well developed uterus full of developing ova and granular material.

The usual pair of longitudinal excretory vessels are present on each side but they are narrow with exceedingly thin walls. The more dorsally situated of these two pairs of longitudinally vessels is so much reduced in size that it is especially difficult to detect on the dorsal side of the segments. Passing from these vessels and distributed in a network throughout the substance of the proglottids are numerous subsidiary vessels, many of which are practically as large as the longitudinal collecting ducts. The longitudinal vessels and the accompanying longitudinal nerve cords are situated in the characteristic positions ventral to the sexual ducts.

The sexual ducts open constantly on the dextral side of the strobila with the apertures near the middle of the segment margin. All the specimens examined have been sexually functional. The first signs of the developing testicular follicles are to be found in about the sixth segment behind the scolex. The ovarian follicles commence to appear shortly thereafter and both male and female organs are fully formed in the eleventh or twelfth segment.

The vagina in its fullest stage of development is a thin walled con-

volute tubule running along the ventral wall of the cirrus pouch to open in a very small atrium that also receives the cirrus organ. In later segments the vagina has degenerated. It has already received its store of sperm which is found accumulated in a capacious receptaculum.

The testicular follicles in their fullest development are oval to fusiform in shape, measuring, on the average, 0.15 to 0.07 in diameter. They extend in a field two to three deep in both dorsal and dorso-ventral planes between the longitudinal excretory vessels on either side. Their number, not possible to estimate accurately, is probably between 150 and 250. As the male gonads proceed to function, the sperm passes into a massive vesicula seminalis which may be divided into two compartments and comes to lie over the terminal part of the cirrus pouch on the dorsal aspect of the latter. The cirrus pouch is a thick muscular organ that may attain a length of 1.3 mm., but may be a third or even more shorter in the younger segments. In it, sperm may accumulate in a so-called internal vesicula seminalis of relatively small dimensions. The cirrus may be everted from its pouch to a length of more than 1 mm. It is then in a favorable condition to observe that it is densely covered by minute spines. When not everted, the cirrus organ lies coiled in its pouch.

The ovary is composed of clavate acini extending for approximately two-thirds of the width of the segment from a level near the proximal end of the cirrus pouch. The vitellarium is also a large follicular structure composed of innumerable small chromophilic cells. It is situated on the poral side at about a third of the distance across the segment. The so-called "shell" gland is situated between the main lobes of the vitellarium and fragments of the ducts that carry the sperm for the fertilization of the ova from the receptaculum are to be seen in favorable sections but no attempt was made to reconstruct this complex of fine ducts.

The uterus, which is first seen as a tube with narrow lumen and thickly nucleated walls in about the twelfth segment, grows rapidly and by numerous outpocketings of its walls produces a sacculated organ filled with innumerable developing ova of minute size together with much granular material. While these ova attain a size of about 15 μ in diameter and are enveloped in a thin membranous covering, even in the largest ultimate segments which are on the verge of separating from the stobila, embryos with the typical pyriform apparatus and a refractile cuticularized shell are not to be found. The presumption is that in this species where sterility is not a factor to be considered, the development of the fertilized ova proceeds to completion after the segments are detached from the parent colony.

Anoplocephaline tapeworms from various species of *Rhinoceros* have been the subject of numerous reports and considerable difference of opinion is expressed as to their systematic positions and relationships. The first record was by Peters who, in 1856, briefly described a tapeworm 120 mm. long and 27 to 29 mm. in maximum width from *Rhinoceros bicornis* (= *R. africanus*) from Mozambique. This tapeworm received the name *Taenia gigantea*.

Murie (1870) described, under the name *Taenia magna*, incomplete tapeworms with "segments $1\frac{1}{2}$ inches broad and 1 inch long" taken from the Indian rhinoceros, *R. indicus*. It was later shown that what Murie believed to be single isolated segments actually represented entire strobilas from which the scolices had fallen. In 1871 Peters erected a new genus, *Plagiotaenia*, to accommodate *Taenia gigantia* Peters, 1856. Garrod (1877) described a tapeworm from a Javanese specimen of *R. sondaicus* and identified it with *Taenia gigantia*, which had been previously described by Peters and by Murie. Garrod's description, like the descriptions of the previous authors, is concerned entirely with external features in the morphology and is by modern standards very inadequate. The full length of his specimens is not specifically mentioned but they were certainly considerably more than 10 cms. and the segments attained a width of 31 mm.

In 1891, E. Blanchard ascribed the species *Taenia gigantia* and *T. magna* from rhinoceroses to his genus *Anoplocephala* united under the single name, *A. gigantia*. Diener (1912) presented the first comprehensive study of the internal anatomy of the tapeworm from *R. indicus*. He described this under the name *Anoplocephala latissima* since Murie's specific name was preoccupied in this genus by *A. magna* (Abilgaard, 1879) from the horse. Diener concluded that *A. latissima* was distinct from *A. gigantia* of Peters and of Garrod on the basis of such dubious characters as the size and disposition of the scolex as described by these authors.

MacCallum and MacCallum (1912), presumably unacquainted with Diener's excellent morphological study, gave an account of the anatomy of fragments of a tapeworm passed by a specimen of "*Rhinoceros sondaicus*" in the New York Zoological Garden.* The fragments, 25 mm. broad, were stated to have been parts of an enormous worm up to 20 feet in length and, on account of the alleged length of the worm, the species was identified with Peter's *Taenia gigantia*. Southwell (1921) accepting the description given by the MacCallums' to represent *A. gigantea*, described as a distinct and new species, *A. vulgaris*, tape-

* Seemingly some confusion developed in the identification of the host, which was actually *R. sumatrensis*. The animal was sold by the New York Zoological Society and its skeleton was eventually deposited in the U. S. National Museum in Washington.

worms from 44 to 75 mm. long and from 11 to 27 mm. wide collected from *R. bicornis* in N. E. Rhodesia. In 1922 Southwell identified as belonging to the same species *A. vulgaris*, a specimen bearing the host label *R. sondaicus* in the collection of the Indian Museum.

In 1926 Stunkard published a detailed study of numerous specimens of a tapeworm collected in the Congo from the white rhinoceros, *Ceratotherium simum cottoni*. These worms, which he identified with Peter's *T. gigantia*, measured up to 120 mm. in length and 20 mm. in breadth. Stunkard critically reviewed the subject of *Rhinoceros* tapeworms and revived the genus *Plagiotaenia* of Peters, at the same time creating the new species *P. longa* for the worms described by the MacCallums and by Garrod. More recently Baer (1927) in his monograph on the family Anoplocephalidae has combined all the species described from the rhinoceroses of Africa and Asia under the single name *A. gigantia*, although in a previous paper (Baer, 1923) he had decided that the tapeworms of rhinoceroses represented at most a subspecies of the equine *A. magna* (Abilgaard).

It is as difficult to judge the propriety of this action as it is to support the contention of a plurality of species. It is well known that tapeworms of this genus and of related genera are subject to marked variation in such characters as the length of the chain, size and shape of the scolex, and the number and dimensions of the individual segments. This has been particularly stressed by Yorke and Southwell (1922) in their study of *A. perfoliata*.

The variation in shape of the strobila as a whole is dependent on the fixation treatment which almost always results in a good deal of contraction. The contraction in length, however, is usually compensated by an expansion in width and thickness. In our material, while some specimens are slightly thicker than others, the width of chains of approximately equal numbers of segments does not differ conspicuously.

The problem of the specific status of our material would be practically insoluble were the specimens immature or were they sterile as is so frequently the case in representatives of the genus. But, although the fully developed embryo with its pyriform apparatus and external chitinous shell membrane are not found even in the ultimate segments that are about to be shed from the strobila, the probabilities are, as we have already stated, that the specimens are as mature as they are likely to be found in the strobilate condition. This character may, perhaps, be taken as distinctive of the species.

Unfortunately, the reproductive and excretory systems in the genus *Anoplocephala* present such uniformity of essential organization as to afford no significant characters for the definition of species and, despite the well known potentiality of varying in these matters, size relation-

ships still appear to be accepted as the best criteria for defining the species. Such are the characters which are presented, presumably for the purposes of comparison, in the tabulated list of species in the Baer monograph.

The possibility of recognising a multiplicity of species of *Anoplocephala* derived from the various species of *Rhinoceros* is rendered more difficult by the phenomenon of sterility that has been encountered in a certain proportion of strobilas and by the fact that in other strobilas the maturation of segments is often unaccountably delayed or even, apparently, suspended. Consequently it becomes difficult to determine on what material from different host reservoirs comparison may be legitimately instituted. It is because our material present proglottids in an advanced state of sexual maturity that we believe that it may be compared with previously described species in all their ranges of specific variation. While in the size of scolex and suckers, cirrus pouch and developing ova, our specimens present nothing to distinguish it from other species, actually the length and width of the strobilated colony make it the smallest species described in the genus. Comparing it with the species, single as believed by Baer or multiple as other authors presume, described from the African and Asiatic rhinoceros, it is difficult to concede that our largest strobila, composed of from 20 to 25 segments measuring barely 12 mm. in combined length and not more than 9 mm. in maximum width, can be identified with *A. gigantia*, the most juvenile specimens of which, having about 50 segments, measure 20 mm. in length (Stunkard, loc. cit., p. 2). Mature specimens in Stunkard's collection measure up to 120 mm. in length and 20 mm. in width. A comparable mature specimen with about 100 segments in Diener's material (Diener, loc. cit., p. 351) measures 56 mm. in length with segments as broad as 26 mm. Nor can the present species, for which I think the name *diminuta* is appropriate, be harmonised with the species described by the MacCallums. This species, named *Plagiotænia longa* by Stunkard, attains a breadth of 6.5 to 7.5 cms. and is said to be as long as 20 feet (6 meters). Even Garrod's specimens attained a breadth of 31 mm.

It is, then, on the consideration of the size of the fully developed strobila that the parasite dealt with in the present paper is submitted as a new species. On this basis of comparison it appears to be most closely related to *Anoplocephala manubriata* described by Railliet, Henry and Bauche (1914) from *Elephas indicus* in French Indo-China.

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HELMINTHS AND COCCIDIA FROM OHIO BOBWHITE¹

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During the fall and winter months of 1931-1932, sixty-seven adult Ohio bobwhite, *Colinus virginianus virginianus* Linnaeus, were examined for helminths and coccidia.

NEMATODES. Five species of nematodes representing four genera were recovered. They are: *Dispharynx spiralis* (Molin, 1858) Skrjabin, 1916; *Seurocyrnea colini* (Cram, 1927) Strand, 1929; *Heterakis gallinae* (Gmelin, 1790) Freeborn, 1923; *Heterakis bonasae* Cram, 1927 and *Subulura strongylina* (Rudolphi, 1819) Raillet and Henry, 1912.

Lesions due to nematodes were found in birds infected with *D. spiralis* and *S. colini*.

CESTODES. Fragments of cestodes, probably of the genus *Hymenolepis*, were found in two quail. The author is indebted to Miss Eloise B. Cram who examined slides of this material.

COCCIDIA. At least three distinct species of coccidia occur in Ohio bobwhite. Since two of these species have not previously been reported from the bobwhite, but were described from the chicken as host, it is thought wise to give the more important characteristics of these infections as they occur in the bobwhite.

Eimeria dispersa Tyzzer, 1929. The outstanding characters of this species are the absence of a well defined polar inclusion in the oocyst and relatively large size. The oocysts are ovoid in shape. Measurements of twenty-five from one quail gave an average of 23.2×18.7 micra, a maximum of 24.0×20.4 micra and a minimum of 22.2×18.4 micra. Measurements were always taken from sporulated oocysts. The oocyst walls are noticeably thinner than in other species. The space between the slightly contoured protoplasmic mass and oocyst wall is small. Oocysts placed in 2.5 per cent aqueous solution of potassium bichromate and allowed to stand in syracuse watch-glasses will mostly sporulate in twenty-four hours; no unsporulated oocysts are found after forty-four hours. Infection occurs throughout the small intestine. Infected epithelial cells of the villi sometimes have the entire host cell nucleus obscured by the developing parasites.

Eimeria tenella Raillet and Lucet, 1891. The oocysts of this species are ovoid in shape. Thirty oocysts from one bird gave an average of 22.4×18.5 micra. A polar inclusion is present. There is considerable

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unfilled space between the protoplasmic mass and the oocyst shell. The protoplasmic masses in many oocysts immediately after removal from the caecum were round in outline, but after several hours all were indented or deeply contoured in outline. Twenty-four hours after being covered with 2.5 per cent potassium bichromate the protoplasmic content of each oocyst divides into four irregular cells. The spores are oval and well defined sixteen to eighteen hours later. There is considerable unfilled space in the sporulated oocyst.

One quail apparently had a pure infection of this species. The caecal content contained large numbers of oocysts, none were found in the small intestine. The caecal walls exhibited hemorrhage. Strings of sloughed off mucosa contained one to five oocysts in a cell. Ten of the large second generation schizonts gave an average measurement of 55.5×42.2 micra. Three of the second generation merozoites gave an average of 20.1×3.4 micra. All measurements were taken from fresh material under pressure of a cover glass. Prepared sections of the caecal wall showed colony formation, the gland cells being heavily parasitized. Oocysts taken from the caecal content of this bird were allowed to sporulate and then fed to two chickens. One chicken, after passing much blood, died six days later. The caecal walls showed severe hemorrhage. No oocysts were found. The second chicken passed considerable blood and on the eighth day many oocysts were found in the faeces. This chicken became emaciated and on the fourteenth day was killed. The caeca, distended with blood and sloughed off mucosa, contained numerous oocysts. The lower part of the small intestine was also infected. The symptoms and lesions exhibited by this bird were typically those of an *Eimeria tenella* infection.

Eimeria acervulina Tyzzer, 1929. The oocysts of this species are egg shaped. They are considerably narrower at one end than at the other. Twenty-five oocysts gave an average size of 21.3×16.7 micra. There is much unfilled space within the unsporulated oocyst. Its protoplasm is round and usually near the center. The nucleus is well defined. The polar inclusion, if single, is large, round or oval in outline and not thick. Often several small inclusions are present, as many as nine being found several times. When several are present they are scattered in diverse places; when one is present it is invariably in the small end. All polar inclusions are highly refractive and always present before the protoplasmic mass shows any signs of cleavage.

One quail had a heavy infection of this species. No other species was present. Developing forms were found in the first half of the small intestine with infection heaviest immediately below the gizzard. Numerous sloughed off epithelial cells containing developing stages or mature oocysts were found in the intestinal content. Developing

forms occurred in both glandular and epithelial cells, and were in most cases above the host cell nuclei, often forming colonies. These colonies in heavy infections are usually grouped together and are evident, macroscopically, in the fresh intestinal mucosa as white spots. Oocysts taken from the alimentary tract of this quail were all sporulated within twenty-four hours. The spores are oval and there is considerable unfilled space in the sporulated oocyst. Two chickens fed these oocysts remained negative.

The chickens used in all feeding experiments were White Leghorns, four weeks old. They had been raised in the Poultry Department, Ohio State University, under ideal conditions of cleanliness. Whether coccidial infection had been in the flock was not known, but no chicks had died of coccidiosis. In preparation for the experiments the chicks were transferred to an unused insectary, where no chickens had ever been and at least one half mile from where any chickens were kept. Precautions were taken with the food and water so that coccidia could not be introduced through it. Faecal examinations were made on three successive days preceding the feeding of sporulated oocysts. The controls were kept in the same room as the experimental birds. No oocysts were recovered from any of the controls at any time.

No pathological conditions were observed in those birds infected with *E. dispersa*. In birds infected with *E. acervulina* and especially with *E. tenella* lesions in the form of enteritis, hemorrhage and sloughed off mucosa were found when the infection was heavy.

TABLE I.

Parasite	Number of infected birds	Per cent of infection	Numbers per infected bird	
			Average	Greatest
<i>Heterakis gallinae</i>	25.	37.31	3.08	9.
<i>Heterakis donasae</i>	9.	13.41	4.	11.
<i>Subulura strongylina</i>	8.	11.94	39.75	134.
<i>Seurocyrnea colini</i>	2.	2.98	2.	2.
<i>Dispharynx spiralis</i>	7.	10.44	2.43	4.
Cestodes	2.	2.98		
Coccidia (all species)	32.	47.76		
Birds negative for parasites	15.	22.38		

SUMMARY

1. Sixty-seven adult Ohio bobwhite *Colinus virginianus virginianus*, shot on the wing in the field, have been examined for helminthic and coccidial parasites.

2. Five species of nematodes were found. They are *Dispharynx*

spiralis, *Seurocyrnea colini*, *Heterakis gallinae*, *Heterakis bonasae*, and *Subulura strongylina*.

3. Fragments of cestodes probably of the genus *Hymenolepis* were recovered from two birds.

4. Three species of coccidia, *Eimeria dispersa*, *Eimeria tenella*, and *Eimeria acervulina*, have been found.

5. *Eimeria tenella* and *Eimeria acervulina* have not previously been reported from the bobwhite. *E. tenella* was successfully transmitted from the bobwhite to the chicken.

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ATTEMPTS TO TRANSMIT YELLOW FEVER VIRUS WITH *TRITOMA MEGISTA* (BURMEISTER)*

by

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In a search for possible accessory vectors of yellow fever virus in Brazil, attention has been directed to the insect family Reduviidae (Hemiptera). Davis and Shannon (1) already have recorded a few experiments with *Triatoma megista*. One experiment, not entirely conclusive, indicated that the virus of yellow fever remained alive in this species for seven days.

Monteiro (2, 3) produced a fatal infection in a rhesus monkey by the injection of the accumulated feces passed by two bed-bugs between the second and the twelfth day after a blood meal on an infected monkey. In two experiments the dejecta collected during the first day after an infective meal contained no demonstrable virus. Injection of feces passed on the fifteenth day by six bugs gave rise to immunity without a febrile reaction. Kumm and Frobisher (4) by injecting suspensions of whole insects obtained no definite evidence that virus persisted in bed-bugs beyond the second day after a meal on infectious blood. Philip (5) was able to produce no infections by the bites of bed-bugs, or by the injection of the same insects into rhesus monkeys; the bugs had been kept after their infective blood meal for "appropriate intervals to allow for incubation." The bed-bugs used by Kumm and Frobisher were *Cimex hemipterus*; those used by Philip were *C. lectularius*; those used by Monteiro were not identified as to species.

Several months ago a colony of *Triatoma megista* was established in the laboratory at Bahia by Dr. H. W. Kumm. The battery jar used for breeding is fitted with an inner perforated chamber of wood, in the manner described by Cesar Pinto (6). A guinea-pig is introduced once each week to furnish blood for the insects. The colony has flourished; it is now possible to obtain at any time large numbers of all stages from egg to adult.

In experiment 2 (table I) death of rhesus A1 resulted from the injection of triatomas at the end of six days after the infective blood meal. In the same experiment a severe attack of fever, with recovery and subsequent immunity, followed the injection into rhesus A2 of

*The studies and observations on which this paper is based were conducted with the support and under the auspices of the International Health Division of the Rockefeller Foundation.

TABLE I.—Transmission Experiments with *Triatoma megista*

Experiment No.	Monkey No. Source of Virus	Days after Infection Blood Meal	Experimental Procedure			Result in Test Animal		
			Triatoma Bites	Injection of Triatomas ²	Infection of Triatoma Feces ³	Fever	Death from yellow Fever	Subsequent Immunity
1	A6	2	—	11 larvae and small nymphs	—	+	—	+
		3	—	10 large nymphs	—	+	+	—
		4	—	10 larvae and small nymphs	—	+	+	—
		7	—	17 larvae and small nymphs	—	—	—	—
		7	—	1 large nymphs	—	—	—	—
		7	3 small nymphs 2 large nymphs	—	+	—	—	—
		14	—	10 small nymphs 5 small nymphs 10 large nymphs 10 small nymphs 10 small nymphs 14 small nymphs 12 small nymphs	—	—	—	—
2	A7	4	—	9 small nymphs 1 large nymph	—	—	—	—
		5	—	—	—	—	—	—
		6	—	—	—	+	+	—
		7	—	—	—	+	+	—
		6	—	—	—	+	+	—
		6	—	—	—	+	+	—
		8	—	—	—	—	—	—
3	A8	10	—	9 small nymphs 1 large nymph	—	—	—	—
		10	—	—	—	—	—	—
		10	—	—	—	—	—	—
		45	—	18 small nymphs 2 large nymphs	—	—	—	—
		29	10 (?) nymphs	—	—	—	—	—
		14	—	19 nymphs of various stages	—	—	—	—
		14	—	—	—	—	—	—
4	A3 A9 A10	10	—	—	—	—	—	—
		10	—	—	—	—	—	—
		45	—	—	—	—	—	—
		29	—	—	—	—	—	—
		14	—	—	—	—	—	—
		14	—	—	—	—	—	—
		14	—	—	—	—	—	—

² At 14 days serum gave negative protection test in mice. Test dose at 21 days was survived without fever (equal dosage of virus killed rhesus B5).

³ Died from intercurrent disease.

⁴ Serum protective to mice. Monkeys resisted immunity test without reaction.

⁵ All suspensions were made in 10 per cent normal monkey serum.

⁶ Large nymphs = in most cases first stage, occasionally second stage, nymphs.

⁷ Temperature rose to 104° F. on day following inoculation, probably because of local reaction at point of injection.

⁸ = died.

TABLE II.—*Interrupted Feeding Experiments with Triatoma megista*

Experi- ment Number	Source of Virus, Monkey Number	Time Applied to Source Animal, Minutes	Test Animal, Monkey Number	Time Applied to Test Animal, Minutes	Death of Test Animal (Yellow Fever)	Subsequent Immunity in Test Animal	Control Animal, Monkey Number,	Death of Control (Yellow Fever)	Subsequent Immunity in Control	Numbers of Triatomas Used in Experiment
5	A 8	5	C 9	30	-	-	D 3	+	-	10 large, and 15 first stage nymphs.
6	A 3	7	C 10	60	-	-	D 4	-	-	4 adults; 7 large nymphs.
7	A 9	6	C 4	40	-	-	C 1	+	-	4 adults; 7 large nymphs.
8	A 10	9	D 1	30	-	-	D 5	-	+	3 adults; 8 large, and 11 small nymphs.
9	C 7	-*	D 2	-*	-	-	D 6	+	-	2 larvae; 9 first stage nymphs; 2 second stage nymphs; 2 third stage nymphs.
10	C 8	-*	A 5	-*	+	-	D 7	-	+	1 third stage nymph; 20 larvae and first stage nymphs.

* Triatomas were applied individually both to source animal and to test animal.
+ = died.

triatomas at the end of seven days from the infective feeding. In experiment 3 immunity without clinical attacks of yellow fever followed the injection of triatomas at six, eight, and ten days from the ingestion of virus.

Twenty nymphs of various sizes were allowed to feed on infected rhesus A3 on April 6, 1932 (experiment 4). After 16 days and again after 31 days the same insects were applied to other infected monkeys; however, it is not known that every individual fed upon these later occasions. It is thought that every nymph went through at least one ecdysis during the period of 45 days between the initial blood meal and the final feeding on a normal monkey. On May 21 about half of the lot fed on normal rhesus A4. Neither this animal nor the one injected with the ground-up insects subsequently showed any reaction. The sera from both animals remained negative in mouse protection tests with yellow fever virus.

Three experiments in which triatomas fed on fresh monkeys after an incubation period, and three experiments in which triatoma feces were injected, all gave negative results. Feces were collected for the 24-hour period preceeding a blood meal and for one or two hours after a blood meal; containers soiled by dejecta were washed with the inoculating fluid, a 10 per cent solution of normal monkey serum.

The problem of transmission in interrupted feedings is quite different from that of transmission after an extrinsic incubation period; there is involved no question of the survival of virus in the insect host. Six interrupted feeding experiments were performed. In four experiments the triatomas were placed in a small glass preparation dish and were applied directly to shaven skin of the infected monkey for a space of five to nine minutes; at the end of this period transfer was made at once to the test animal. It is not known how many insects fed in each instance on the infected monkey; subsequent injection into control animals proved that in at least three of the four experiments some infectious blood had been ingested. In the fifth and sixth experiments triatomas were fed individually both on the source animals and on the test animals. It is known that every insect punctured the skin of an infected monkey and began to feed, and that with no appreciable delay it completed its blood meal on a non-infected monkey. A fatal infection resulted from feeding on the test animal (rhesus A5) in the last experiment.

DISCUSSION

It might be possible in rare circumstances for triatomas to act as agents in the transfer of yellow fever virus in nature, if after an infective blood meal they should be mashed on the skin of a susceptible person. Such instances probably would be fortuitous, because a triatoma

once engorged is not likely to seek another blood meal during the week in which infective virus remains in its body. The occurrence of mechanical transmission in nature is equally improbable.

The mid-gut of an engorged triatoma frequently contains red, undigested blood even after six or seven days. It is possible that the virus remains alive in the intestinal contents without invading the tissues of the insect.

When triatomas, more particularly large nymphs and adults, are applied to a monkey, they appear excited, and often pass some time running about before they settle down to feed. The actual engorgement occupies five minutes or more. A hungry triatoma, once it has decided to feed, is not easily discouraged by experimental manipulations; an interrupted meal is readily resumed on a second host.

Considering the extremely minute dose of virus which is sufficient to infect a monkey (one cubic centimeter of a 1-1,000,000,000 dilution of infectious blood - 7), it is remarkable that mechanical transmission by biting insects has proved to be so difficult to accomplish.

Both Philip (5) and Kumm (8) failed to secure infections by interrupted feeding of *stegomyia* mosquitoes. Philip (5) also failed with bed-bugs. Kumm (8) infected two monkeys in interrupted feeding experiments with vampire bats.

SUMMARY

1. The injection into rhesus monkeys of *Triatoma megista* after a meal on infectious blood caused:

- a. At intervals of three to six days, death of the test animals with yellow fever.
- b. At an interval of seven days, fever, followed by immunity to yellow fever.
- c. At intervals of eight and of ten days, no fever, but immunity to yellow fever.
- d. At an interval of fourteen days, neither fever nor immunity to yellow fever.

2. After periods comparable in length to the extrinsic incubation period of the virus in mosquitoes, triatomas which had previously ingested infectious blood were unable to transmit yellow fever by biting. Even at earlier periods the feces of the insects were non-infective.

3. In one experiment yellow fever was transmitted mechanically to a test monkey by the bites of triatomas after an interrupted blood meal on an infected animal.

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AUTOMATIC DISTRIBUTION OF PARIS GREEN FOR MALARIA CONTROL¹

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FOREWORD

Malaria control is a more difficult problem in the tropics than it is farther south or north: not because larvicides do not kill as easily there as elsewhere, but because labor is so undependable that it requires unusual effort to take larvicides to larvae; not because bed-nets are more porous there than elsewhere, but because average rural dwellers in hot countries prefer risking underestimated chances of mosquito-borne disease to taking overestimated chances of increasing their nocturnal discomfort; not because plasmochin and quinine kill parasites any less readily there than elsewhere, but because in those latitudes the effort and inconvenience of taking medicine are more affective deterrents to systematic treatment; not because local health officers do not know the theory of malaria control, but because in the tropics, more surely than elsewhere, "mosquito doctors" lose face in direct proportion to their zeal in carrying out antimosquito measures.

Moreover, in the tropics generally, housing, drainage, and public health are backward, ignorance of hygiene is greater among the laity and nonchalance towards illness and death more complete.

There is also, of course, the fact that in some portions of the tropics *Anopheles* breeding is continuous throughout the year. However, in limited areas, as in the Ilocos and Cagayan regions of Luzon in the Philippines, dry months cause as complete seasonal suppression of *Anopheles* breeding as do cold months in temperate zones.

Pervading all of the factors which militate against effective malaria control in the tropics is a paralyzing lack of funds. Per capita yearly expenditures of G\$1 or more for malaria control are out of the question. The practical limit of expenditure for routine malaria control possible to the average town of 10,000 inhabitants in the Philippines, over and above salaries and expenses of public health personnel already existent, is not more than 5 cents gold per capita per year, and it would be impossible to obtain as much as this in many places. On the private hacienda, with sugar, copra, rubber, and other agricultural products selling at bottom prices, very little money is available for sanitary measures.

¹ These studies were made at the Calauan, Laguna, laboratory of Malaria Investigations, a project jointly supported by the Bureau of Science, Manila, and the International Health Division of the Rockefeller Foundation.

Finally, there is the patent truth, which experience has made more obvious, that for road repairs and sterilization of drinking water, as well as for malaria control, no end is in sight. The period of time over which control measures will have to be practised stretches into the next century and beyond. Permanent, year-by-year, systematic appropriations are required rather than short-lived campaigns which, as Filipinos say, are cogon-grass fires, than which nothing seems so brilliant but which die so quickly.

It is no wonder that intelligent laymen in high administrative places in the tropics are becoming increasingly pessimistic about malaria control. In medical ranks, too, there are dissenters; and even among malariologists there is a tendency to discredit the method of mosquito control first advised and so ably preached by Ross (1).

Upon analysis, it is seen that the economics of malaria control resolves itself into two factors—time and money. These two factors are always present, but are inversely proportional to each other. Given plenty of money, effective malaria control can be accomplished, despite all handicaps, in a relatively short time. The construction of the Panama Canal is a good example of an undertaking for which time was short and money plentiful. Practical control was quickly realized, although it must be remembered that malaria has never been entirely eradicated from the Canal Zone.

The average tropical country today has plenty of time but little money. It begins to be evident that malariologists in these regions will have to rely more and more upon time and less and less upon money, abandoning all hope of speed, looking ahead by decades rather than by single years.

Moreover it would seem that all available methods of control should be utilized rather than, as the League of Nations advises, with Europe as a test, that only one or another particular method should be employed in a given place. No single approach to malaria control in the tropics will be more than partially effective. Yet each will add its quantum; and the combined effect will in due time be a reduction in the density of mosquito and human carriers of malaria below the critical numbers necessary for propagation. When the "epidemic potential" is sufficiently low, there will be no transmission of malaria even in the presence of the mosquito vector.

This does not mean that attempts at mosquito control should be abandoned. On the contrary, everything points to the desirability of increasing the emphasis on this method. There is no example of effective control in the tropics by measures which did not include an attack on anopheline mosquitoes. In the Philippines, for example, there is no record in the literature, and no instance coming under per-

sonal observation, of any sudden success in the control of malaria by drugs. Recently, Russell and Holt (2) published the results of an attempt to prevent malaria among laborers on a sugar hacienda by administering chinoplasmin. This experiment illustrates the futility, at the present time, of drug prophylaxis alone. Daily doses of 0.01 gram of plasmochin and 0.3 gram of quinine sulphate, in the form of tablets of chinoplasmin, were not sufficient to prevent the appearance of malaria parasites in all cases, although such doses usually forestalled clinical symptoms. Even twice this dose occasionally failed to prevent the appearance of malaria parasites in the blood. The fact that the parasite index was lower in the treated group than in the controls indicates that mass drug therapy might be a gain in the direction of malaria control. But it is too slight to justify the use of chinoplasmin alone in attacking the disease.

As a matter of fact, the cost of drug control of malaria is relatively great. If, in order to sterilize the blood of human malaria carriers in a community of 10,000, it were necessary to give 3,000 persons one standard treatment of quinine each, the cost would be at least G\$1,750, and if chinoplasmin were administered, the cost would be G\$4,000, at the present government prices for the drugs in large quantities. A final and overwhelming consideration is the fact that it is impossible to get a population to take prolonged standard treatments of any kind, even if they are given without charge.

On the other hand there are several successful instances of malaria control in the Philippines largely by antimosquito measures. Consult, for example, Tiedeman (3), Mieldazis (4), Lovewell (5), Parsons (6), and Norris (7). Malaria is also being controlled by anti-mosquito measures on the island of Corregidor.

But in these cases the cost of antilarval measures has been higher than that allowable for an average Filipino town. Tiedeman's (3) minimum costs were in the neighborhood of G\$.30 per capita, which is probably six times as large as the usual appropriations for such purposes in the Philippines.

Norris (7) reports yearly expenditures of G\$2,500 for malaria control, not counting salaries of the post medical inspector and a staff sergeant. On the basis of a total civilian and military population of about 10,000, the G\$2,500 yearly appropriation is about five times larger than a typical Filipino town of 10,000 inhabitants could afford to spend.

A METHOD OF ANOPHELINE CONTROL

The present paper reports some experiments with a device which spreads Paris green automatically. It is admittedly not a perfect solution of the mosquito problem; but, like experiments with damming and

flushing (8) as a method of controlling *A. minimus*, it is an attempt to replace unsatisfactory labor to some extent and thereby to reduce the costs of antimosquito work. Complete eradication of larvae in a stream has not been accomplished with this machine. But as a matter of experience, it has not been accomplished in the Philippines after the typical laborer has spread Paris green by hand. It is improbable that with present labor, methods, and funds, the anopheline larvae of a stream in the Philippines can ever be routinely eradicated week by week. Such is not the case elsewhere, however. In Sardinia, for example, in September, 1929, I was offered G\$.05 for every larva I could find along 3 kilometers of stream the day after it had been treated with Paris green. This offer was made by the laborer who had spread the larvicide. I accepted the challenge and found only one anopheline larva. This was of the first instar. Such enthusiasm and such meticulous labor are extremely rare in the tropics.

But, as Ross (9) has shown, it is not essential to destroy all of the mosquitoes. If their numbers can be materially reduced, and if this diminution in the insect host can be supplemented by a lessened acces-

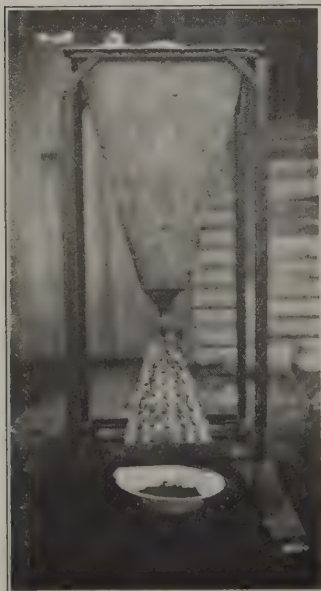


Fig. 1. Distributing machine, gravity type, for Paris green-sand mixtures. Front view.



Fig. 2. Distributing machine, gravity type, for Paris green-sand mixtures. Side view.

sibility of man, through the use of bed-nets, and by a curtailed supply of gametocytes through the administration of chinoplasmin, the incidence of malaria is bound to fall. Given time, malaria will certainly disappear from a region under these conditions, even though both bed-nets and drugs are utilized by only a portion of the population.

The experiments reported below must, then, be regarded in the light of the foregoing remarks. Other studies are in progress with other types of automatic devices for the distribution of Paris green mixtures. Our goal is the construction of a mechanically efficient automatic blower, motivated by the flow of water in the stream under treatment. The local malaria-carrying *Anopheles minimus* group breeds chiefly in streams.

THE DISTRIBUTING MACHINE

The machine tested in these experiments is a gravity-type distributor for mixtures of sand and Paris green. It is not suitable for diluents finer than sand. As will be seen from an inspection of the

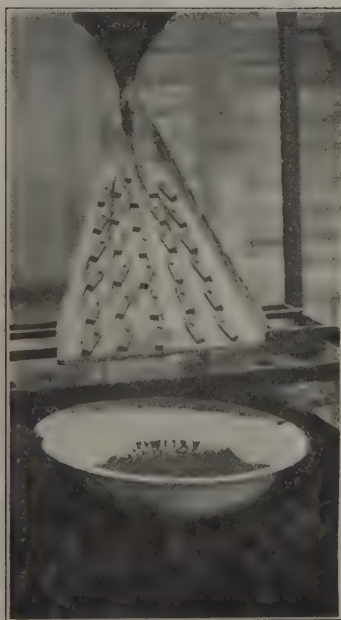


Fig. 3. Distributing machine, gravity type, for Paris green-sand mixtures. View of baffle-board distributor.



Fig. 4. Distributing machine, gravity type, for Paris green-sand mixtures, in place over Ilat Stream in Masiit, Laguna Prov. Looking up stream. Front view of machine.



Fig. 5. Looking down the Ilat Stream, Masiit, Laguna Prov. Notice that the stream banks are covered with vegetation. No clearing of the banks was attempted during the experiments.



Fig. 6. Branch of Macalauan Stream showing rear view of nipa shed protecting the distributing machine for Paris green-sand mixtures. Notice typical grassy stream banks. No clearing was attempted during the experiment.

photographs, it consists essentially of a hopper for a supply of the larvicide mixture, a spout for slow delivery of this mixture, and a baffle-board to facilitate the distribution. The dimensions of the machine as follows:

Height, $34\frac{1}{2}$ inches,

Width, 22 inches,

Breadth, $21\frac{1}{2}$ inches,

Capacity, 100 liters,

Rate of flow (average) 180 cc. per minute.

The hopper is made of sheet tin, and the sheltering hut is of nipa palm. The machine can be built for about G\$25.

EXPERIMENTS

This machine was first placed over the Ilat Stream in Masiit, Laguna Province. It was supported on a bamboo bridge about 5 feet above the surface of the stream. Along the stream banks, for a distance of about 300 meters below the machine, catching stations were established, 108 in all. One dip was made at each station, and the larvae were turned back after counting. Previous catches from this stream indicate that *A. minimus* and *A. barbirostris* are the chief species

breeding in it. The depth of the stream varies from about 15 to 50 centimeters and the width from 1 to 2½ meters.

TABLE 1.—Total weekly routine counts of anopheline larvae at 108 catching stations on the Ilat Stream during an experiment with a Paris green-sand distributing machine

Date	Total larvae counted	Remarks
1931		
Oct. 22.....	511	No Paris green
29.....	524	" " " } Intermittent
Nov. 5.....	634	" " " rains
12.....	44	Paris green applied
19.....	70	" " "
26.....	681	No Paris green
Dec. 10.....	1751	" " "
17.....	5531	" " "
24.....	4279	" " "
1932		
Jan. 7.....	2162	No Paris green
16.....	287	Paris green applied
21.....	4029	No Paris green
28.....	229	Paris green applied
Feb. 6.....	1551	No Paris green
11.....	158	Paris green applied
18.....	2226	No Paris green
25.....	110	Paris green applied
March 3.....	4486	No Paris green

TABLE 2.—Distribution of larvae at 108 dipping stations along Ilat stream on two of the catching days during experiment

[illegible]

In Table 1 is a record of weekly routine catches from October 29, 1931, to March 3, 1932, with notations as to when the Paris green mixture was applied. Table 2 is presented to show the typical distribution of larvae along the stream before and after applying the Paris green with this machine. Catching Station 1 is farthest downstream, and Station 108 is just below the machine.

Early in March the machine was moved to a branch of the Macalauan Stream in Calauan. This is a narrower and swifter stream, with grassy banks. It is also an *A. minimus* breeding place. Table 3

TABLE 3.—Routine weekly counts of larvae at 50 regular catching stations on branch of Macalauan stream during experiment.

Date	Total larvae counted	Remarks
1932		
Feb. 19.....	388	No Paris green
26.....	111	No Paris green
March 4.....	15	Paris green applied
11.....	501	No Paris green
18.....	18	Paris green applied
25.....	516	No Paris green
April 2.....	17	Paris green applied
9.....	18	Paris green applied
16.....	13	Paris green applied. No fully grown larvae seen.

presents the result of routine weekly counts at the fifty catching stations established along this stream. Station 1 is about 125 meters below the machine. Station 50 is nearest to the machine, about two meters

TABLE 4.—Distribution of larvae at 50 regular dipping stations along branch of Macalauan stream on two occasions during experiment

Catching station	Larvae counted		Catching station	Larvae counted	
	Mar. 25	April 2		Mar. 25	April 2
1	32	0	26	0	0
2	8	0	27	0	0
3	2	2	28	8	0
4	13	0	29	31	0
5	14	0	30	0	0
6	19	0	31	8	0
7	72	1	32	5	0
8	4	0	33	11	0
9	18	0	34	0	0
10	32	0	35	0	0
11	9	0	36	4	0
12	11	0	37	0	0
13	2	0	38	1	0
14	26	0	39	0	0
15	31	0	40	3	0
16	0	0	41	3	0
17	1	0	42	14	1
18	4	0	43	4	0
19	2	0	44	0	0
20	12	2	45	46	3
21	3	0	46	12	4
22	5	0	47	5	2
23	0	0	48	6	0
24	0	0	49	8	0
25	23	2	50	4	0
TOTALS				516	17

below it. In Table 4 are listed the catches, station by station, on two occasion, in order to show the typical distribution of larvae.

The larvicide used in these experiments was sand and Paris green, thoroughly mixed, 99 parts to 1 by volume. Dry, sifted sand was used. The Paris green had the usual specifications as to color, consistency, and arsenic content. The flow from the machine was not continuous, as the mixture had a tendency to clog. Usually about 50 liters of the mixture was put into the hopper and this poured out intermittently over a period of about 10 hours. There was some uncontrolled variation in this. The amount of larvicide used was relatively large and could undoubtedly be considerably reduced.

DISCUSSION

One fact is evident from the tables, namely, that whenever the larvicide was allowed to fall on the stream from this automatic machine there followed a marked reduction in the numbers of larvae. The effect of the Paris green was apparent even 300 meters downstream (catching stations 1 to 5) as shown in Table 2. This was true although, as stated above, sand was the diluent and, as is evident in the photographs, the sides of the stream were far from being clean. Particles of Paris green could be detected along the entire length and breadth of the stream. Eddies and whirlpools helped to distribute the floating particles. At the machine, air currents helped materially to spread the larvicide. The only cleaning that was done was the removal of three branches on one occasion when they lay across the stream and acted as a screen to keep back the Paris green.

The same definite effect of the Paris green was seen in the second stream as in the first, Tables 3 and 4.

The chief advantage of such a machine is that, by reducing labor and inspection to a minimum, it would lower the cost of mosquito control considerably. But it has obvious disadvantages which limit its usefulness at present. It is admittedly a first attempt at the solution of a difficult problem, which, so far as the literature indicates, seems not to have been experimented with before.

SUMMARY

The difficulties of malaria control in the tropics are briefly discussed in a foreword. There are reported two experiments with an automatic distributing machine from which a mixture of sand and Paris green falls on a stream continuously for some hours each week. A large proportion of the anopheline larvae breeding in streams were killed by the Paris green so distributed, even at a distance of 300 meters downstream.

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A SPECIES OF *HEXAMITA* (PROTOZOA, FLAGELLATA)
FROM THE INTESTINE OF A MONKEY
(*MACACUS RHEBUS*)

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INTRODUCTION

Protozoa belonging to the *Hexamita* group of flagellates are widely distributed in nature, occurring in both fresh and sea water and associated with a wide variety of animal hosts, including terrestrial, freshwater and marine invertebrates, and all classes of vertebrates. Until recently, however, they had not been definitely recognized as inhabitants of any of the primates. Although Chalmers and Pekkola (1916) reported "*Octomitus hominis*" from man, Wenyon (1926) has shown that this flagellate was a *Trichomonas* (*Pentatrichomonas*). Furthermore the flagellates called "*Octomitus*" by Chatterjee (1922) from man and by Chatterjee, Nath and Mitra (1928) from the gibbon, can scarcely be accepted as members of the *Hexamita* group, since in both cases they apparently are mononucleate and lack the characteristic axostyles and posterior flagella. On the other hand, DaCunha and Muniz (1929) have noted the presence of a member of this group which they call "*Octomitus pithici*," in the feces of *M. rhesus* monkeys that had been imported into Brazil.

Recently, I had an opportunity to study fecal material from a rhesus-monkey which contained a similar flagellate. Since such flagellates seem to be rare in the primates, and since the form I have studied appears to differ somewhat from that described by DaCunha and Muniz, it seems worth while to put my observations on record. I am indebted to Mr. R. E. Stadleman for the opportunity to examine monkeys at the Sharp and Dohme Biological Laboratories, Glenolden, Pa.

Material from four monkeys was obtained, but only one harbored the octoflagellate to be described below. Fresh feces of this monkey were collected immediately after defecation, diluted with a small amount of weak Ringer's solution and transferred to the Zoological Laboratory of the U. of P. where the material was examined and slides made. Smears were fixed in Schaudinn's and Hollande's fixatives and stained with iron alum-haematoxylin.

Besides the species of *Hexamita* this monkey harbored two species of *Trichomonas*, a *Chilomastix*, a *Retortamonas* (*Embadomonas*) and amoebae similar to *Entamoeba coli* and *Iodamoeba bütschlii*.

DESCRIPTION

These flagellates were not very numerous and very few observations were made on them in the living state. However, they could be recognized by their small size, their shape, and their characteristic movements which were very rapid and similar to those of other members of the genus *Hexamita*.

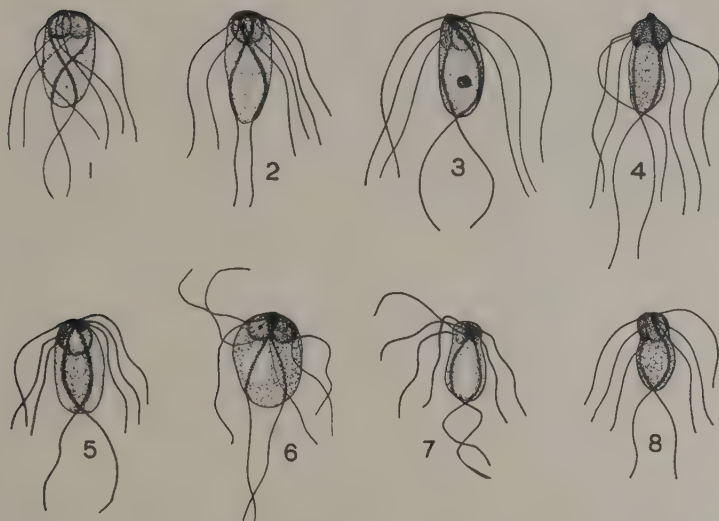
Study of the prepared material revealed a small hexamitid about twice as long as wide, usually rounded anteriorly and tapering somewhat posteriorly, with the usual six flagella originating from the anterior end and two posterior flagella arising as continuations of the axostyles which traverse the length of the body.

Measurements of 100 specimens gave a range of length from 4μ to 6μ with an average of 4.96μ , and a range in width from 2μ to 4μ with an average of 2.49μ . A great majority of the specimens approximated this ratio of length to width although some were more inflated through the mid region (Fig. 6) and others were more slender (Figs. 2 and 4).

The multiplicity of details renders the organization of the anterior portion of the body difficult of analysis. In most specimens seen on the slides the six anterior flagella were directed posteriorly and tended to adhere more or less to the body surface. The proximal portions of these flagella with the basal granules, the two nuclei and the anterior portions of the axostyles are so crowded together that it is difficult to recognize the individual parts. The flagella are usually about twice as long as the body, although in many specimens they were not arranged so as to reveal their full length.

As is common for species of *Hexamita*, the axostyles arise from opposite sides of the anterior end of the body from the region of the blepharoplasts. As is also the rule in this genus, the longitudinal planes for the axostyles and the nuclei are at right angles to each other at the anterior end; hence in specimens oriented to show the nuclei in the horizontal plane the two axostyles lie in the vertical plane (Fig. 6) at their origins. The three flagella on each side arise from blepharoplasts near those of the axostyles. In some individuals the blepharoplastic region projects anteriorly as a ridge which is conical in optical section (Fig. 4). Figure 1 illustrates the wide separation of the axostyles at their proximal ends. They tend to follow a spiral peripheral course through the cytoplasm and from their posterior extremities the posterior flagella emerge. It seems probable that these so-called axostyles constitute the intracytoplasmic portions of the posterior flagella, with a sheath of differentiated cytoplasm surrounding them.

The two anteriorly located nuclei may be either rounded (Figs. 1 and 6) or somewhat elongated (Figs. 3, 5 and 8) in contour. They



Figures 1-8 showing different individuals of the *Hexamita* found in the feces of a monkey (*Macacus rhesus*). All drawings were outlined under a camera lucida at a magnification of 4000, but are reduced about 1/3 in printing. Fig. 1. Body somewhat inflated; axostyles far apart anteriorly, following a spiral course through cell. Fig. 2. A narrower specimen. Fig. 3. Individual with included body, probably food. Fig. 4. Individual with anterior ridge (conical in optical section). Fig. 5. Another position of nuclei and axostyles is shown. Fig. 6. Inflated specimen with large clear vacuole. Figs. 7 and 8. Smaller specimens.

were difficult to study, often being too darkly stained for analysis. In some individuals the nuclei appeared to be homogeneous but in others were vesicular, showing a central or somewhat excentric chromatin mass with a layer of chromatin or a series of chromatin granules against the nuclear membrane (Figs. 1 and 6). In none of these, however, was there a clear-cut caryosome.

The cytoplasm was fairly homogeneous in texture in many individuals (Figs. 4 and 5) while in others it was more vacuolated (Figs. 6 and 7). Occasionally a vacuole included what appeared to be a food body (Fig. 3).

Altogether the structure of this species is typical for the *Hexamita* group of flagellates.

DISCUSSION

There are a number of striking differences between the flagellate just described and that reported by DaCunha and Muniz from the same host. These authors give dimensions as from 2.5μ to 3μ in

length by $1.5\ \mu$ to $2\ \mu$ in width, indicating a much smaller organism than the one described above. They also show the six anterior flagella extending out forward from the body, while in my material they tended to be directed posteriorly (on prepared slides). The axostyles in their illustrations are rather far apart but they are not represented anteriorly and neither the spiral twist nor the peripheral position are indicated. These authors figure two minute deeply-staining nuclear bodies about $\frac{1}{4}$ the body length from the anterior end. The appearance and the location of the nuclei as figured by them are strikingly different from the vesicular structure and anterior position of the nuclei in the specimens of my material. In spite of these differences, it would perhaps be unwise to propose a new species name, since the study of DaCunha and Muniz was based on a few animals and further studies may reveal greater similarities than are apparent at present.

In regard to nomenclature, it may be pointed out that the genus *Hexamita*, established by Dujardin (1841) for both free-living and endozoic species, should probably be retained as Wenyon (1926) has done, rather than be replaced by *Octomitus* Prowazek (1904). Hence, this species from the monkey is provisionally placed in the genus *Hexamita* Dujardin.

SUMMARY

A species of *Hexamita* was found in the feces of a monkey (*Macacus rhesus*). It ranged from $4\ \mu$ to $6\ \mu$ (ave. $4.96\ \mu$) in length and from $2\ \mu$ to $4\ \mu$ (ave. $2.49\ \mu$) in width. The flagella are about twice as long as the body; the anterior three pairs tend to trail posteriorly (on prepared slides). The axostyles arise far apart anteriorly and follow a peripheral spiral course to the posterior end where they are continuous with the posterior flagella. The anteriorly located nuclei appear to be vesicular and may be round or elongate-oval in contour. The cytoplasm is sometimes homogeneous, sometimes vacuolated and occasionally contains what appear to be food bodies.

Although there are a number of striking differences between this flagellate and that described as "*Octomitus pithici*" by DaCunha and Muniz (1929), no new species name is proposed. The genus name *Hexamita* Dujardin, 1841, is employed rather than *Octomitus* Prowazek, 1904.

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CROSS-INFECTION EXPERIMENTS WITH COCCIDIA OF RODENTS AND DOMESTICATED ANIMALS*

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A long series of cross-infection experiments by a considerable number of workers has contributed to the belief that coccidia, particularly those of the genus *Eimeria*, are notably host-specific. Since excellent summaries of these experiments have already been compiled by Andrews (1927), Corcuff (1928) and Yakimoff and Iwanoff-Gobzen (1931), it is unnecessary to review them here in support of the generalization. There are on record, however, a few exceptions to the general rule. Dieben (1924) made some successful interspecific crosses when he infected black, brown, and albino rats with *Eimeria miyairii* taken originally from either black or brown rats. Tyzzer and Jones (1929) succeeded in infecting turkeys and chickens with *Eimeria dispersa* of the quail, and the quail with *E. dispersa* of the pheasant; but their other cross-infection attempts involving chickens, pheasants, turkeys, and quail, on the one hand, and *E. dispersa* of the quail, *E. dispersa* and *E. phasiani* of the pheasant, *E. acervulina* of the chicken, and *E. meleagridis* of the turkey, on the other hand, gave either negative or inconclusive results. Furthermore, Andrews (1927) showed that *Isospora rivolta* and *I. felis* of the dog and cat are infective to both animals, and C. D. Lee (unpublished work) has found that the silver fox likewise is a susceptible host for the *Isospora* of cats and dogs. There have been other claims of successful interspecific infections with coccidia, but attempts to confirm them have generally resulted in failure.

For the past fourteen months the writer, in collaboration with Miss Phoebe R. Hall, has been interested in the coccidia of rats, of which two authentic species are known—*Eimeria miyairii* and *E. separata*. The rat hosts being used in the experiments are raised in the laboratory from immune and coccidia-free parents, kept on screens after attaining the age of two weeks, and examined at frequent intervals in order to verify their freedom from coccidial infection. Since one objection to many reported negative cross-infection experiments has been that the worker reporting did not sufficiently exclude the possibility that his trial hosts had not become immune previous to the cross inoculation, the possession of animals known to be susceptible and coccidia-free suggested that further cross-infection experiments would be in order.

* This work was supported by a grant from the Rockefeller Fluid Research Fund at Iowa State College.

Furthermore, *Eimeria separata* had not been used previously in attempts to infect animals other than rats, although this was not true of *E. miyairii*. The experiments were planned mainly around the white rat as a trial host and its two previously mentioned species of coccidian parasites as the infective agents, but it was found feasible to employ also a number of other trial hosts and coccidia.

Experiment 1. Six white rats about 42 days old were each fed in milk 1 c.c. of a fairly heavy culture of sporulated *E. magna* oocysts from a tame rabbit. The same material was used successfully at the time to infect a wild rabbit. Fecal examinations of the rats were negative 4, 5, 6, 7, 10, 12 and 14 days later.

Experiment 2. Four white rats about 42 days old were each fed on bread several c.c. of mixed cultures of coccidia taken from pigs and permitted to sporulate in the laboratory. The cultures were given to the writer by Dr. H. E. Biester, who made a tentative diagnosis of the species present as *E. scabra*, *E. debliciecki*, and *E. perminuta*. Dr. Biester was using this material to infect pigs at the time, a fact attesting to the viability of the material. Fecal examinations of the rats were negative 4, 5, 6, 7, 10, 12 and 14 days after feeding the microorganisms. (Dr. Biester permits the writer to state that his attempts to infect pigs with *E. miyairii* and *E. separata* of the rat resulted negatively.)

Experiment 3. Two white rats about 42 days old were each fed in milk three c.c. of a fresh culture containing small numbers of completely sporulated oocysts of *Eimeria faurei* from sheep. Fecal examinations of the rats were negative 4, 6, 8, 10, 12, 14 and 21 days later.

Experiment 4. Four white rats about 6 weeks old were each fed on bread one c.c. of fresh culture material containing numbers of sporulated *E. smithi* from a calf. Fecal examinations were negative 4, 6, 10, 15, 20 and 25 days later.

Experiment 5. Four white rats about 6 weeks old were each fed on bread 1 c.c. of a culture containing numerous recently sporulated oocysts of *Eimeria tenella* and the same amount of a similar culture of *Eimeria maxima*, both parasites of the chicken. The material was obtained by the writer through the kindness of Dr. C. D. Lee. Fecal examinations of the rats were negative 4, 5, 6, 8, 10, and 12 days later.

Experiment 6. Thirteen adult white mice in a cage of quarter-inch hardware cloth, and, later, fourteen half-grown mice in another cage, were fed a bowl of bread and milk containing several million sporulated oocysts belonging to *Eimeria separata* and *E. miyairii* of the rat. The adult mice were coccidia-free at the time of the experiment, but there was no record of their past history. The young mice were raised by the writer and carefully examined at frequent intervals to verify their freedom from coccidia. Fecal examinations of these mice were made

4, 6, 8, 10 and 12 days after the infective feeding, and resulted negatively. The method used was salt-flotation of the fecal material collected in a pan of water placed beneath the cage.

Experiment 7. At the conclusion of Experiment 6, the 27 mice were fed a bowl of bread and milk containing some of the culture of the sporulated oocysts of porcine origin used in Experiment 2, and some of the rabbit coccidia used in Experiment 1. Fecal examinations of the mice 4, 6, 8, 10, 12 and 14 days later were all negative.

Experiment 8. Two half-grown guinea pigs, at one time, (one of which had a very light infection with *Eimeria caviae*), and one, at another, were fed in a moist grain mixture a few c.c. of mixed culture material containing a large number of oocysts of *E. miyairii* and *E. separata* of the rat and *E. magna* of the rabbit. The fecal examinations were negative 4, 6, 8, 12, 16 and 22 days later except that the one guinea pig continued to eliminate the oocysts of *E. caviae* at various intervals. The value of this experiment is not great because the past history of the trial hosts as to coccidial infection was unknown to the writer.

Experiment 9. Four striped ground squirrels (*Citellus tridecemlineatus*), which had been kept on screens by Mr. Homer Hixson to use as hosts for ticks, were each fed on bread 1500 sporulated oocysts of both *Eimeria miyairii* and *E. separata*. The fecal examinations were negative 5, 7, 9, 11, and 13 days later. The value of this experiment is not great, because the past history of the trial hosts as to coccidial infection were not known to the writer. Kartchner and Becker (1930) have previously reported their unsuccessful attempts to infect white rats and house mice with *Eimeria citelli* of the striped ground squirrel.

Experiment 10. A sporulated culture of oocysts from the infected guinea pig mentioned in Experiment 8 was fed to two half-grown rats. The feces were negative for oocysts up to four weeks later.

Experiment 11. A quarter-grown cotton-tail, *Sylvilagus floridanus mearnsi*, which was taken when a nestling and raised by hand and known to have never become infected with coccidia, was fed in milk several c.c. of culture material containing viable oocysts of *Eimeria separata* and *E. miyairii* of the rat. Examinations were negative on the fourth, sixth, eighth, tenth, and twelfth days.

Experiment 12. At the completion of Experiment 11, the cotton-tail mentioned, and, later, another young cotton-tail captured when small and shown by fecal examination daily for three weeks to be coccidia-free, were each fed 50,000 sporulated oocysts of *Eimeria magna* from a Belgian hare, *Lepus cuniculi*. In each case, on the fourth day after the infective feeding typical oocysts of *E. magna* were found in

the fecal pellets. The first rabbit died on the tenth day in a greatly emaciated condition. The parasites were numerous in scrapings from the intestine, but there were no liver lesions. The second rabbit was killed on the eighth day. The intestine was enormously distended with gas, parasites were present in intestinal scrapings, and there were no liver lesions.

It should be mentioned that the two species of rat coccidia employed in some of these experiments were obtained originally by Becker and Hall (1932) from the Norway rat, but have been successfully grown in white rats.

DISCUSSION

The experiments herewith reported mostly favor the generalization that coccidia of the genus *Eimeria* are highly host-specific. The two species of known rat coccidia, for example, will not come to maturity in even such close relatives of rats as mice. The rat, in turn, even when as young as six weeks, can not serve as a suitable host for coccidia from other rodents, such as guinea pigs and rabbits, and from the ordinary domesticated animals. The negative results thus confirm in part and supplement those of Dieben (1924). The fact that even young mice and rats will not serve as hosts for coccidia from mammalian species considerably removed shows that the factors which determine host-specificity are probably deeply rooted in the species, and not to be confused with the phenomenon of age resistance. (Cf. Sandground, 1929.)

The striking success in infecting the cotton-tails with *Eimeria magna* from the Belgian hare was altogether unexpected, for systematic zoologists customarily place the two species in separate genera. Furthermore, there is no clear evidence that the two animals are capable of cross-fertilization. In fact, an outstanding geneticist recently told the writer that his efforts to secure offspring from mating the two rabbits have invariably met with failure. Then, too, there was to be considered Nieschulz' (1923) unsuccessful attempts in Holland to infect tame rabbits with *Eimeria leporis* from hares.

CONCLUSIONS

1. The rat, even when quite young, is not susceptible to infection with *Eimeria magna* of the rabbit, *E. scabra*, *E. deblickei* and *E. perminuta* of the pig, *E. faurei* of the sheep, *E. smithi* of the ox, *E. caviae* of the guinea pig, and *E. tenella* and *E. maxima* of the chicken.

2. The rat coccidia, *E. miyairii* and *E. separata*, are not infective to mice—even when they are quite young, cotton-tail rabbits, guinea pigs, and striped ground squirrels.

3. A previously unreported interspecific cross-infection is possible—*Eimeria magna* Pérard from the Belgian hare (*Lepus cuniculi*) can complete its development and produce pathological symptoms, and even death, in the North American cotton-tail rabbit (*Sylvilagus floridanus mearnsi*).

4. *Eimeria separata* and *E. miyairii* obtained from the wild Norway rat, *Epemys norvegicus*, can be successfully cultivated in the albino rat, derived originally, of course, from the Norway rat.

5. A number of other attempted cross-infections resulted negatively.

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IN MEMORIAM

CONSTANTIN JANICKI

Notice was recently received of the death on October 25, 1932, of Professor Dr. Constantin Janicki, director of the Zoological Institute of the University of Warsaw. Dr. Janicki is widely known for his part in the solving of the life cycle of *Diphyllbothrium latum* in 1917 and for his numerous other researches on the morphology and life cycles of tapeworms. Returning to Poland after the war Dr. Janicki developed an important center for helminthological research in the University of Warsaw, and attracted a number of students and younger investigators into this field. His death at the height of his activity deprives this group of its leader and the field of helminthology of an important worker.

JOHN E. STUMBERG (1905-1933)

The sudden death of Dr. John E. Stumberg on January 20 from heart involvement following an attack of influenza came as a great shock to his friends and associates. Dr. Stumberg was in his 28th year and just at the beginning of a promising career in research. He was a graduate of Washington University in St. Louis and had also received the Master's degree for work in that institution in cytology. Later taking up further graduate study in the Department of Helminthology of the School of Hygiene and Public Health of the Johns Hopkins University he received the D. Sc. degree in 1931. During this period he spent five months in Puerto Rico on immunological problems in human helminthology. Following his doctorate came a fellowship in the Department of Animal Pathology of the Rockefeller Institute at Princeton, N. J., where he was actively engaged in investigations up to the time of his death. Dr. Stumberg chose as his field of research the difficult subject of the immunological phases of helminthology. He was well trained in immunology and in the related medical sciences. Beside four papers already published, another had just gone to press the week he died. His publications testify to a good grasp of his problems and gave promise for the future. Dr. Stumberg had an unusual knowledge of the technic in his field and had read very widely for a man of his age. He was always ready to give of his time and energy to help his associates. Quiet and unassuming with the highest ideals, he was a hard worker and enjoyed the esteem and friendship of all those with whom he was associated. His loss at the very beginning of his career will be keenly felt and regretted by all those who knew him.

REVIEWS AND NOTES

A GUIDE TO HUMAN PARASITOLOGY FOR MEDICAL PRACTITIONERS. With two colored plates, and one hundred and twenty-two illustrations in the text. 271 pp. By D. B. Blacklock and T. Southwell. New York.

This book consists of concise directions for the identification of animal parasites which may be found in man. It is devised primarily for use by physicians, and to that end the descriptions of disease-producing organisms are especially emphasized. The plan of the book includes (1) consideration of the technique necessary for the preparation and examination of parasitological specimens of various sorts, (2) text descriptions of parasitic spirochaetes, protozoa, and helminths found in man, (3) a chapter on human myiasis, (4) a collection of diagrams illustrating pictorially the life-histories of human helminths, (5) a series of tables which effectively analyze and cross-index the epidemiological features of human parasitism, and (6) lists of drugs and dosages used in treating parasitic infections of man. No attempt is made to present a bibliography but a few of the larger texts on parasitology are specified for the benefit of those users who desire to supplement their parasitological information. The book is well indexed.

The authors have deliberately contracted and organized the mass of diagnostic information regarding human parasites which exists and is variously presented in different parasitological texts. They have made a commendable and, as far as the reviewer can judge, a successful attempt to separate the essential from the non-essential facts. To do this they have freely dogmatized on controversial subjects but always from the conservative point of view. Classification, superfluous descriptive details of pathogenic forms, and consideration of non-pathogenic species have been subordinated to emphasize by means of textual description, keys, and tabular arrangements of diagnostically-valuable characters the identification of the common parasitic protozoa and helminths of man.

The writers have premised the position of absolute ignorance of parasitology on the part of the reader. The book is therefore particularly valuable for self-instruction in the subject, and should be a welcome and useful manual in connection with courses in human parasitology offered to students of medicine and public health. It is clearly written and the descriptions are straightforward and simple. The diagrams and pictures which supplement the text are quite adequate both from the point of view of number and clarity. The surprisingly few typographical errors and other defects of a first edition will undoubtedly be corrected in subsequent impressions.

JUSTIN ANDREWS

MEDICAL ENTOMOLOGY. A Survey of Insects and Allied Forms which Affect the Health of Man and Animals. By W. A. Riley, Ph.D., Sc.D., and O. A. Johannsen, Ph.D. McGraw-Hill Book Co., New York and London. 476 pp., 184 figs., 1932.

This text on medical entomology is a revision of the well known "Handbook of Medical Entomology" published by the same authors over a decade ago. In the original edition the subject-matter was arranged under such general headings as poisonous forms, parasitic species, etc., being thus grouped largely according to the nature or habits of the species treated. In this revised edition the material is grouped according to the systematic position of the species concerned. There are twenty-four chapters in all, followed by an appendix on hydrocyanic acid gas fumigation and thirty pages of bibliography. The titles of the bibliography are arranged alphabetically according to authors. In this work the literature has been well reviewed, and there are frequent citations in the text; often in fact direct quotations are given, thus making the book valuable

for reference. The figures are many and in most instances of good quality. An abundance of data is given on the biology of many species and a full treatment of disease transmission. Species noxious to man, as well as the genera or higher groups that contain them, are frequently keyed. Such keys are a great aid to identification. Finally, the whole volume is presented in an attractive form by the publisher. It is printed on good quality paper and bound in buckram.

H. E. EWING

ECONOMIC MAMMALOGY. By Junius Henderson and Elberta L. Craig. 397 pages. Charles C. Thomas, Springfield, Ill., and Baltimore, Md.

As the title indicates data of an economic nature with respect to the relations between man and other mammals are brought together in this treatise. General subjects are considered in Part I which consists of 184 pages and a systematic account is contained in Part II of 160 pages. There is a bibliography of 26 pages and an index. The sections of particular interest to parasitologists are Chapter XII (8 pages) on the Diseases and Parasites of Mammals, and Poisoning from Plants, and Chapter XIII (6 pages) on Mammals as Disease Carriers and Disseminators. The space devoted to these chapters has allowed little more than an opportunity to include a list of subjects under these titles. Reference is made to Texas fever in cattle, the heel-fly, tularemia, lungworms, liver flukes, intestinal worms, lice, ticks, rabies, bubonic plague, spotted fever, trichiniasis, African sleeping sickness, and other diseases and vectors that involve mammals.

ROBERT HEGNER

MEDICAL ENTOMOLOGY. By Robert Matheson, Ph.D. 489 pages. 211 text figures. Published by Charles C. Thomas, Springfield, Illinois. 1932.

This excellently printed and well illustrated volume presents a complete and up to date survey of the Arthropods which transmit human diseases. The first two chapters are introductory. Chapters III and IV deal with the ticks and mites. Chapter V contains a brief but thorough discussion of the structure, biology and classification of the true insects. Chapters VI and XVIII include the treatment of the four orders of insects which are of great medical importance, chapter VI taking up the Hemiptera, chapter VII the Anoplura, chapters VIII to XVII the Diptera and chapter XVIII the Siphonaptera. Chapter XIX deals with the venomous spiders, scorpions, etc., and with urticating and vesicating insects, while chapter XX contains instructions for collecting, preserving, mounting, dissecting and rearing insects. Full author and subject indices are added. A list of important references is placed at the end of each chapter, where it is readily accessible to the reader.

Under each group the author gives a brief discussion of external and internal anatomy, classification and biology, followed by a more detailed consideration of the biology of important disease-carrying species. He then takes up the various diseases transmitted by these species and the methods used in their control. The emphasis laid on the biology, both of the groups and of the particular species concerned in disease transmission, is one of the most valuable features of the book.

My main criticism of this excellent text would be that the author has adhered too literally to the implications of his title. Material which belongs to Veterinary rather than to Medical Entomology has been largely excluded, and the keys and the treatment of particular genera and species are almost entirely restricted to forms of known medical importance. This may have been necessary in order to include the valuable material on biology and yet keep the size and price of the book within reasonable limits. However, if it had been possible to cover also some of the forms of veterinary interest and other related types, the broader outlook thus attained would have added greatly to the value of the work.

FRANCIS M. ROOT

PROCEEDINGS OF PATHOLOGICAL SOCIETY, ARGENTINE

The proceedings of the Séptima Reunión de la Sociedad Argentina de Patología Regional Del Norte form an impressive record in 2 volumes of 1059 pages with many text figures and plates. The material is grouped in 7 sections; one section is devoted entirely to human and comparative parasitology although all of the sections contain clinical papers in this field.

INSTRUCTIONS FOR COLLECTORS—No. 12—WORMS—BRITISH MUSEUM (NATURAL HISTORY)

This pamphlet of 22 pages is one of a series issued for the information of collectors sending material to the British Museum. It covers both the free-living and parasitic worms. The first part gives a discussion for the amateur collector of how to distinguish the main groups of worms and where to look for them. In the section on parasitic worms detailed directions are given for making host examinations and for preserving the specimens found. The section on how to label and pack specimens is very much to the point. The value of a pamphlet of this sort will be readily appreciated by specialists who constantly receive material from non-specialist collectors so badly preserved and poorly labeled that it cannot be used for identification or study.

AMERICAN SOCIETY OF PARASITOLOGISTS

Eighth Annual Meeting, Atlantic City, New Jersey, December 28, 29 and 30, 1932

Sessions of the 8th annual meeting of the American Society of Parasitologists were held Wednesday to Friday, Dec. 28-30, 1932, in the Municipal Auditorium at Atlantic City, under the presidency of Maurice Crowther Hall. The program, following substantially its printed form in the December issue of the JOURNAL OF PARASITOLOGY, occupied five half-days, and was notable not alone for the quality of its papers, but for the increased proportion of reports on protozoological subjects. On Wednesday afternoon, through the kindness of Dr. R. B. H. Gradwohl, moving pictures made by the Institut für Schiffs und Tropenkrankheiten, Hamburg, and illustrating the life history of *D. latum* and *E. histolytica*, and *Balantidium coli* were shown. On Wednesday evening the Society held, at the Chelsea Hotel, its second annual dinner, with over 60 present. This was followed by the annual business meeting. On Thursday afternoon, Dr. Hall gave his presidential address, exploring with wit and wisdom the question, "Is Parasitology a Science?" Followed demonstrations of parasitological interest conducted by members Alvey, Chitwood and Wehr, Geiman, Glaser, Meleney, J. W. Scott, Skinker, Septima Smith, Troisi, and Wallace. This demonstration period, with which the annual tea of the Society is habitually combined, proved deservedly one of the most agreeable and valuable features of the program. It will interest the membership generally that the annual meetings show a steady increase in the number of papers presented. The Atlantic City meeting was the first in the Society's history made up entirely of contributed papers, there having been no invitation papers, symposia or joint sessions, and the total program bulked larger than ever before.

At the Council Meeting on Dec. 27th, the following actions were taken:

1. Reports of the Treasurer and Secretary were received, examined, approved and adopted. The 1932 fiscal year ended with receipts of \$535.89 and a deficit of \$13.37, and a membership of 491, of which 8 were life and foreign honorary.

2. Nine applicants were elected to active membership.

3. The following foreign honorary members were elected: H. A. Baylis of England, E. Martini of Germany, Ed. and Et. Sergeant of Algeria and France, and K. I. Skrjabin of Russia.

4. A previous action to participate in the June, 1933, Chicago meeting was rescinded, and the following motion passed: In the absence of official Society participation, consideration will be given by the officers of the Society to invitation from any A. A. A. S. section which has in its program a foreign visitor the subject of whose address will be of interest to parasitologists, to the end of developing an invitation program for one or more sessions; and W. H. Taliaferro is appointed Chicago representative to have charge of such participation.

5. Boston, with the A. A. A. S. in December, 1933, was approved as the place and date of the ninth annual meeting.

6. The Council approved the proposal of Dr. H. W. Stunkard to develop an endowment fund in the Society, the income of which shall be used to underwrite publication and research in the American Society of Parasitologists.

7. Following a discussion of the problem of program development for the annual meeting, the Council voted that each member of the Society be allotted not more than 15 minutes program time, to be used in person or by introducing a non-member.

8. After consideration of the nominations for 1933 officers made by members of the Society through the Secretary's office, the Council presented a list of nominations to the annual business meeting of the Society.

9. The Council met in a body with the Editorial Board of the Journal of Parasitology, to discuss problems related to the JOURNAL OF PARASITOLOGY.

At the annual business meeting of the Society on Dec. 28, 1933, the following transpired:

1. The report of G. Steiner, Chairman, Committee on Nomenclature, was approved and adopted, to wit:

The Secretary of this Society submitted to the Committee on Nomenclature two matters for an opinion:

A. In February, 1932, a circular letter No. 220, Series 1931, was received from the Secretary to the International Commission on Zoological Nomenclature. This letter concerns various amendments to the international rules in regard to family names. The proposition involved concerns the question of priority in family names. After consideration of the matter, the Committee concluded to submit to this Society the following resolution for action:

The American Society of Parasitologists is opposed to the establishment of a law or of strict rules of priority in regard to family names in zoological nomenclature, as proposed in the amendments by Prof. Bradley and others, because:

First: The classification of many animal groups is still in the making. The establishment of strict priority in regard to family names would undoubtedly tend to ossify and fossilize a situation in an immature stage, and would prevent the worker from applying new facts in a proper and free way, since age and not fitness or logic would have to govern him in giving family names.

Second: It is doubtful whether the strict application of priority would be possible in all instances because of the ambiguity of group designations in many of the older papers.

Third: Priority has nothing whatever to do with the fitness of a genus as type of a family or subfamily but would under the suggested rule be the deciding factor.

Four: It is desirable and logical that a family name be formed after the most typical, the most central of its genera. The proposed priority rule would make this impossible in many instances.

Five: Unfortunately there are at present already a number of family names based on rather atypical "edging" genera. Strict application of the priority rule would greatly increase the number of such rather undesirable family names.

Six: There are instances where, under the rule of priority, incompletely known or even doubtful genera would have to be used as types for family names, when better known or fully assured genera are available.

Seven: It would involve the establishment of obsolete names in place of many well established family designations now in use and widely applied also in practical life, and thus create confusion in various professional groups such as physicians, veterinarians, plant pathologists, quarantine inspectors, etc., a confusion which would last over a long period of expurgation.

Eight: The application of a priority rule as proposed by Prof. Bradley and others would involve such interpretations of old authors' group names as they never intended them to be, would falsify their views and give them credit for something they never did, often depriving the investigator who ingeniously and laboriously formulated a proper family diagnosis.

Nine: Priority in family names should only be a matter of recommendation to be applied whenever feasible.

Three of the five members of the present Committee expressed themselves with regard to these propositions and all three concurred in the resolution as drafted above.

B. In June, 1932, the Secretary of this Society referred to the Committee a second circular letter from the Secretary to the International Commission on Zoological Nomenclature. See attached letter. This letter brings up the question of homonym of four generic names proposed by Looss in 1899 and 1902, as follows:

Haematoloechus nec *Haematoloecha* Stål, 1874, hemipteron.

Progonus nec *Progona* Bert, 1882, insect.

Macrodera nec *Macroderes* Westwood, ante 1882, coleopteron.

Liopyge nec *Liopygus* Lewis, 1891, 385, insect.

Because of what he considered homonymy, Looss later renamed these genera:

Pneumonoeces, *Genarches*, *Saphedera*, *Liocerca*.

The Committee proposes to this Society that the Secretary to the International Commission on Zoological Nomenclature should be informed that this Society does not consider the above-mentioned generic names to be homonyms, since the rules of nomenclature state that generic names have to be considered as different if one letter is different, and that the Society therefore is of the opinion that the first names as proposed by Looss should be declared valid. Only three members of the Committee expressed themselves in regard to this proposition and all three concurred.

2. The report of W. W. Cort, Chairman, Committee on Necrology, memorializing N. A. Cobb, Joseph Leidy, Jr., and Louis Schapiro, was adopted, to be placed in the records of the Society.

3. Dr. W. W. Cort as Chairman of the Editorial Committee of the JOURNAL OF PARASITOLOGY presented an informal report on the state of the JOURNAL, now in the midst of its first volume under Society auspices.

4. The recommendation of Council that the Society confer life active membership upon Theobald Smith, of Princeton, was unanimously adopted.

5. The recommendation of Council that the Society pass the following minute was carried: That attention of parasitologists be called to the fact that according to a new rule of the International Zoological Congress, effective beginning Jan. 1, 1932, no description of a new species, even in abstract, is valid unless it contain a differential diagnosis; and that when a species, published as new in abstract, is later described in extenso, the paper be given a title different from that of the abstract, and that repetition of the expression "new species" be omitted.

6. Amendments to the Constitution, having been approved by Council on Sept. 24, 1932, and notice given to the membership as of Oct. 1, 1932 ("at least 30 days" before the annual meeting), were unanimously passed so that the appropriate paragraphs read as follows:

Membership. Any person interested in parasitology may be a candidate for active membership.

Officers. The officers of the Society shall be a President and a Vice-President, who shall be elected for one year; a Secretary and a Treasurer, who shall be elected for two years; and Members at Large of the Council.

Dues. The dues, to include subscription to the JOURNAL OF PARASITOLOGY, shall be three dollars the year for active members, unless changed by vote of the Society.

7. Attention was called to the fact that in September, 1932, the American Society of Parasitologists was incorporated in the District of Columbia. "The particular business and objects of said corporation shall be to conduct a scientific society; to publish a scientific periodical; to collect subscriptions thereto; to collect funds for prizes, awards, and for other purposes; to make contracts; to acquire, hold and dispose of real and personal property; to make investments; and to disburse collected funds for expenses, awards and other purposes."

8. The following officers, nominated by the Council, were elected for 1933:

President: W. H. Taliaferro, University of Chicago.

Vice-President: F. C. Bishopp, Bureau of Entomology, U. S. Department of Agriculture.

Secretary: H. W. Stunkard, New York University.

Treasurer: Justin Andrews, Johns Hopkins University.

Council Members at Large for 4 years: H. E. Meleney, Vanderbilt University; Norman R. Stoll, Rockefeller Institute for Medical Research.

NORMAN R. STOLL, *Secretary*.

PROCEEDINGS OF THE HELMINTHOLOGICAL SOCIETY OF WASHINGTON

One Hundred Forty-ninth Meeting

The one hundred forty-ninth meeting was held October 15, 1932, in the United States National Museum. The following officers were elected for the coming year:

E. W. PRICE, *President.*

L. A. SPINDLER, *Recording Secretary.*

E. E. WEHR, *Corresponding Secretary.*

Dr. E. W. Price presided over the meeting.

The committee on the awarding of the Ransom Memorial Prize in Parasitology announced that competing theses must be in the hands of the committee not later than October 1, 1933, and that one thesis, only, is to be submitted from each University. Theses may be submitted from any country.

Papers were presented as shown below.

L. A. SPINDLER, *Secretary.*

1. The experimental transmission of the swine lungworm, METASTRONGYLUS ELONGATUS, to dogs. J. E. ALICATA.

Von Linstow (1906) reported a species of lungworm from the bronchi of a dog, which he named *Cloacina octodactyla*. His description and figures agree well with those of *Metastrongylus elongatus* from swine. In order to determine the possible identity of the two species in question, the writer fed to two one-month-old puppies several earthworms which had been experimentally infected with larvae of *M. elongatus*. One dog died 19 days after the feeding of the infested earthworms. At necropsy, the lungs showed several scattered haemorrhagic areas, and grey consolidation of the posterior tips and along the lateral borders; one of the upper lobes of the lung was completely consolidated. The bronchi and their ramifications were filled with pus; 46 young *Metastrongylus elongatus* were found in the bronchi and bronchioles. The male worms showed well developed bursae, and the females showed well developed uteri and ovaries. One of the largest males was 7.5 mm. long by 114 μ wide. One of the largest females was 14 mm. long by 140 μ wide; the uteri contained unsegmented eggs, 45 to 53 μ long by 30 to 38 μ wide. The second dog was killed 32 days after experimental infection. For about a week before the animal was killed it showed marked dyspnoea and occasional coughing. At necropsy the lungs showed numerous pneumonic lesions, which were similar in appearance to those found in the first dog. In the bronchi were found 14 adult females of *Metastrongylus elongatus*; one of the largest of these worms was 17 mm. long by 187 μ in maximum width. These worms contained unsegmented eggs in the uteri. It should be noted in this connection that Von Linstow in his description of the dog lungworm stated that the eggs contained an embryo.

Since the description and figures of *C. octodactyla* Von Linstow, are in general similar to those of *M. elongatus*, and since the latter can be transmitted to dogs experimentally, *Cloacina octodactyla* is regarded by the writer as a synonym of *Metastrongylus elongatus*.

2. Notes on nematode systematics and nomenclature. B. G. CHITWOOD.

Charonema, Cobb, 1920 of which the type species is *C. simplex* Cobb, 1920 was based on a single larval specimen, which appears to be a larval horse strongyle and can therefore be placed in the genus *Strongylus*. Since the type specimen cannot be found at the present time it is not possible to determine which species of the genus *Strongylus*, *C. simplex* represents.

Trionchonema, Kreis, 1932, type *T. rusticum* Kreis, 1932 appears to be a synonym of *Cosmocercoides* Wilkie, 1930, and the type species should be transferred to that genus. The proper designation of the foregoing species is therefore, *Cosmocercoides rusticum*, Kreis, 1932.

Pelodera axei Cobbold, 1884, appears upon careful study of the description and figures given by Axe in 1884, to be identical with *Leptodera elongata* Schneider, 1866. However *Leptodera elongata* Schneider is preoccupied by *Leptodera elongata* Baird, 1859. Therefore the specific name should be, *axei*. The sub-genus *Rhabditella* Cobb, 1929 seems to be worthy of generic rank. The known species are, *R. leptura* Cobb, 1929; *R. axei* Cobbold, syns. *R. elongata* Schneider 1866; *L. elongata* Schneider, 1866, not Baird 1858; *R. tenuicaudata* Stefanski, 1922; *R. gracilis* Schingarewa and Koudrjawzeff, 1927; and *Rhabditella octopleura* Steiner, 1929 n. comb.

Strongylus catanensis Rezzo, 1902 appears to be a synonym of *Rhabdias fuscavenosa* Ralliet, 1899. B. C. Chitwood.

3. GONGYLONEMA MACROGUBERNACULUM Lubimov, 1931 from two new hosts. JOHN T. LUCKER.

Specimens of *Gongylonema* obtained in Washington, D. C. and from the Zoological Gardens in Philadelphia, from the buccal and oesophageal mucosa of *Maccaca lastiotis* and *Papio rhodesiae*, respectively, appear to correspond morphologically to the forms recently described from related primates by Lubimov (1931) as *Gongylonema macrogubernaculum*.

Lubimov's description indicates that the length of the gubernaculum of the male of this species considerably exceeds that of the right spicule. The writer finds that in some specimens from the above hosts the gubernaculum is but very slightly the longer of the two structures and the measurements obtained from the specimens differ in magnitude from those furnished by Lubimov. The variation in the length of the males is from 11.4 to 15.7 mm; the left spicule is from 4.11 to 5.75 mm. long; the right spicule from 0.082 to 0.119 mm. long and the gubernaculum from 0.097 to 0.136 mm. long. In other particulars Lubimov's description corresponds to the writer's observations.

4. Failure of repeated injections of trichina extracts to immunize rats to trichinosis. JOHN T. LUCKER.

A 1 per cent Coca's solution extract of dried and powdered infective *Trichinella spiralis* larvae was injected intra-peritoneally into white rats in doses of from 1 to 3 cc. at intervals of 4 or more days until a total of 4 or 5 injections had been given. Subsequent administrations of decapsulated infective larvae of *T. spiralis* were given by stomach tube to the rats which received these injections and to control rats. Inconclusive results were obtained in a first experiment involving one rat which had received injections, and two control rats. In a later experiment two rats, which had received 5 injections of antigen each, were given 10,000 infective trichina larvae 9 days after the last injection. The same number of larvae was given to each of two control rats. The four rats died in from 17 to 20 days after the administration of the larvae. Post-mortem examinations indicated that in all instances death was due to trichinosis. It appears that no resistance toward subsequent infection with *T. spiralis* had been conferred upon the two rats which received injections of the extract.

One Hundred Fiftieth Meeting

The one hundred fiftieth meeting was held at the Johns Hopkins School of Hygiene and Public Health, in Baltimore, November 19, 1932, Dr. Justin Andrews presiding. The following minute was passed in regard to the death of Dr. N. A. Cobb.

The Helminthological Society of Washington deeply regrets the sudden death of Dr. Nathan Augustus Cobb. In him the society loses one of its

charter members, an ever present and most active contributor to the scientific programs of its meetings and a most delightful speaker at its dinners. His scientific presentations to this society were remarkable because they bore the stamp of careful observation, novelty of concept even to a complete disregard of old patterns of thought. Dr. Cobb was President of this society from 1916 to 1917. As a scientist Dr. Cobb had an international reputation as the author of numerous fundamental papers in nematology, parasitology, phytopathology, agronomy and cotton fiber standardization. His studies in taxonomy, morphology and physiology of plant-parasitic and free-living nematodes show him as a keen observer and interpreter of living phenomena. He was a brilliant microscopist, better acquainted with the theory and construction of this instrument and shrewder in its application than most biologists. Aside from the scientist the members of the Helminthological Society deplore the loss of Dr. Cobb as a colleague of much personal charm. He was cultivated and reticent, with ever youthful vitality and fascination through his abounding enthusiasm and optimism. Members of this society will deeply miss his tall figure, the rich variety of his topics, his well-nigh perfect illustrations, his amiable innuendos at dinner talks, and express their deep concern and grief for this irreparable loss.

Papers were presented as shown below.

L. A. SPINDLER, Secretary.

1. *The dung beetle, Ataenius cognatus, as the intermediate host of Hymenolepis cantaniana.* JOSEPH E. ALICATA and MYRNA F. JONES.

While examining specimens of a dung beetle, *Ataenius cognatus* in October, 1932, there were found in the body cavity of some of these beetles a natural infestation with a mycelium-like structure containing buds of various sizes, some of which were apparently clusters of tapeworm cysticeroids. Some of the cysticeroids were detached and were found free in the body cavity of the beetles, both in the thoracic and abdominal regions. These larval stages were fed to a rabbit, a mouse and three chicks. They developed and reached sexual maturity only in the chicks. The tapeworms which developed were identified as *Hymenolepis cantaniana*. In one of the beetles harboring a natural infection there were found 1663 fully developed cysticeroids and in another beetle 2217.



Text Figure 1.—*Hymenolepis cantaniana* larvae. Note proliferation of larval tissue. a, b, c, are developing cysticeroids; d, e, f, are apparently mature cysticeroids still attached to larval tissue.

2. *A new intermediate host for CHEILOSPIRURA HAMULOSA, the gizzard worm of poultry.* EUGENIA CUVILLIER.

Nine grasshoppers, identified by the U. S. National Museum as *Paroxya clavuliger* Serv., were fed eggs of *Cheilospirura hamulosa* on July 22 and 23,

1932. All of these grasshoppers either died or were killed between August 23 and September 1, 1932. Five of the 9 insects were found to be infested with nematode larvae having the characters of the infective larval stage of *Cheilosporura hamulosa* as described by Cram (1931). However, the infestation was light in all cases, and subsequent feeding of these larvae to 2 chickens produced no mature worms; the evidence that this worm would be transmitted under natural conditions by *P. clavuliger* is therefore incomplete.

3. *Two new intermediate hosts for the poultry cestode, HYMENOLEPIS CARIOCA.* EUGENTIA CUVILLIER, and MYRNA F. JONES.

A specimen of *Onthophagus janus* (identified by Dr. Chapin) collected at Beltsville, Maryland, was fed segments of *H. carioaca* and *Raillietina* sp. June 3, 1932. The beetle was killed July 6, 1932 and found to contain at least 150 cysticeroids of *Hymenolepis carioaca*. A number of these cysts were fed to a chicken, which was killed 19 days later and examined for cestodes. Numerous specimens of *Hymenolepis carioaca*, some mature or nearly so, were found. No gravid segments were observed. Control chickens were negative.

The beetle and a few cysticeroids were placed in the U. S. National Museum Helminthological Collection as Number 32684; some of the adult worms were placed in the collection as Number 32685.

A beetle, identified by Dr. Chapin as *Onthophagus pennsylvanicus*, was found naturally infected with at least 150 unarmad cysticeroids identified as *Hymenolepis carioaca*. On June 10, 100 to 125 of these cysticeroids were fed to a single chick. The chick was dead on July 5 (25 days after feeding); apparently it had been killed by other birds of the same lot. Post-mortem examination revealed numerous specimens of *Hymenolepis carioaca*; control birds were negative.

The beetle and specimens of the cysticeroids were placed in the U. S. National Museum Helminthological Collection as Number 32683.

4. *A new species of TETRAMERES from the bobwhite.* E. B. CRAM.

Early in the summer of 1931, R. J. Patterson of Mountain Park, N. C., submitted glandular stomachs of bobwhite quail (*Colinus virginianus*), which were severely infected with a species of *Tetrameres*. The bright red female worms which were embedded in the glands of the stomach were so numerous and were individually so large that very little uninfected stomach wall remained; 21 females and 7 males were collected by the writer from one of the stomachs and Mr. Patterson noted that he had observed even heavier infestations. The quail had been trapped in the wild and had died in considerable numbers after a short period of confinement; it is evident, therefore, that the infection had been acquired before the birds' capture. A study of the nematodes led to the conclusion that a new species is involved and the name *Tetrameres pattersoni* is proposed. Characteristics differentiating this species from *T. americana*, the chicken tetramere which may also occur in bobwhites, and from other species of *Tetrameres* are as follows: *Male* 4.2 to 4.6 mm. long by 140 to 170 μ wide; cervical papillae 83 to 112 μ from head end; body provided with 2 rows of spines, originating slightly ventral to, and slightly posterior to, the cervical papillae, swinging more ventrally posteriorly and ending just anterior to cloacal aperture; posterior to cloacal aperture, 3 pairs of lateral, and 4 pairs of sub-ventral, spines; cloacal aperture 256 to 288 μ from tail end; only one spicule, 1.2 to 1.5 mm. long, well-chitinized, with conspicuous cross-striations, and often partially extruded from the body. *Female* about 5 mm. long by 2 to 2.3 mm. wide; vulva about 235 μ , anus about 156 μ , from tail end; a bulbous enlargement between vulva and anus; eggs 42 to 46 μ by 25 to 30 μ . Type-specimens—No. 30573, U.S.N.M. (Bureau of Animal Industry Helminthological Collection).

A new locality record for *T. pattersoni* has recently come to light in the finding of this parasite in a young bobwhite, 10 to 12 weeks old, originating from the eastern shore of Maryland (Easton, Md.), the stomach of the quail having been submitted by H. M. De Volt of the University of Maryland. In addition to 14 female and 8 male specimens of *T. pattersoni* in the anterior part of the glandular stomach, there was a heavy infestation with *Seurocyrnea colini* (12 adult females, 7 adult males and 10 immature specimens), in the posterior part of the stomach.

5. *A nematode, SETARIA LABIATO-PAPILLOSA from the udder of a cow.* G. DICKMANS.

On September 9, 1932 the Zoological Division received from Dr. J. L. Ruble of Orlando, Florida, a nematode with the notation that it had been collected from the udder of a cow. This nematode was identified as *Setaria labiato-papillosa*. Another specimen of this nematode was collected from the pleura of a cow.

6. *ONCHOCERCA GUTTEROSA from the cervical ligament of cattle in Puerto Rico.* G. DICKMANS.

This nematode was reported from cattle in Puerto Rico by van Volkenberg in 1927 under the name of *Onchocerca* sp. Dr. Hall on his last visit to Puerto Rico obtained some fragments of this nematode from which no positive identification could be made. Dr. van Volkenberg recently collected additional material from cattle in Puerto Rico and forwarded it to the Zoological Division for study. Dr. Chitwood examined this material and identified the nematodes present as *Onchocerca gutterosa*.

7. *ONCHOCERCA FLEXUOSA from the subcutaneous tissues of an antelope and from subcutaneous abscesses of a deer.* G. DICKMANS.

This nematode was collected from the under surface of a piece of skin of an antelope, *Antilocapra americana*. The material was collected by Mr. S. B. Locke at Salmon River, Idaho, and sent to Dr. J. E. Shillinger of the Bureau of Biological Survey, who referred the material to the Zoological Division for study. The material from the subcutaneous abscesses was sent to the Pathological Division of the Bureau of Animal Industry by Dr. C. L. Davis of Denver, Colorado, who stated that it was obtained from a deer killed near Boulder, Colorado. In looking over the collection of the Zoological Division it was found that this nematode had been collected by Dr. Albert Hassall in 1893 from the subcutaneous tissues of a deer at Washington, D. C. The identification was made by Dr. Chitwood of the Zoological Division.

The formation of abscesses containing calcified fragments of nematodes, in the subcutaneous tissues of a deer is of interest in connection with reports of similar findings in cases of fistulous withers and poll-evil of horses.

8. *Writing scientific papers for the benefit of foreign readers.* M. C. HALL

Scientists in general appreciate the fact that science is international. Their appreciation is expressed in the highly valuable system of exchanging reprints and in their cognizance of scientific literature published the world over. However, there are certain things which might be done to make the lot of the foreigner somewhat easier in handling this international literature in the many languages in which it appears. In preparing the manuscript of a book, the staff of the Zoological Division has adopted certain policies in their writing with the thought that these policies would make it easier for the foreigner to use the book. These policies are as follows: 1. Whenever possible numerals are used instead of writing out the names of numbers, for the reason that Arabic numerals are internationally used so far as most countries are concerned and

it is not necessary to use a dictionary to translate them. 2. In morphological descriptions, superfluous words are omitted whenever possible in order that the foreigner need not look up words which will add nothing to his understanding of the sentence after he has found them. The words which can be most readily omitted are such words as *is, are, there is, there are, is located, is situated*, and similar expressions. The omission of these words makes it easier to grasp the sense of a statement even for the English reader. Thus the statement: *Spicules straight, colorless, 2 mm. long* is easier to read than: *There are two straight, colorless spicules which are two mm. long*. The saving in expense of publication in using this short form is very considerable and in 1000 pages will easily save thousands of words and a number of pages of print. This short form is a practical compromise between verbose description and the use of formulae and symbols. 3. Along the same line, significant words are placed first in the sentence. This gives the foreigner a clue at the outset as to whether the sentence deals with a subject in which he is interested. In the sentence quoted in the previous paragraph, the brief form beginning with *spicules*, gives the clue to the statement; the expanded form beginning with *there are two straight, colorless spicules* interpolates 5 less significant words in advance of the significant word. 4. Contrary to the common present day tendency, all words compounded with *like* or *shaped* are hyphenated as a clue to the foreigner to the effect that this is a compound word broken at a certain point into its elements and warns him that he may not find this word in his dictionary, while indicating that he will probably find its separated components. 5. Colloquial terms are avoided and the conventional scientific terms are used whenever possible. It is an annoyance to the American reader to find that a parasite structure is described as shaped like the receptacle commonly used for marketing perfume in Hongkong, since the odds are a thousand to one that he will not know what is the form of the receptacle so used. Such terms have little more usefulness than the slang expression "as long as a piece of string."

We owe it to the foreigner to take cognizance of the fact that science is international and to write our papers in the form in which it is easiest for him to read them. When we do that we shall be in a better position to urge that our foreign colleagues supply us with abstracts in the romance or teutonic languages of papers published in Slavic, Japanese, Magyar, and similar non-teutonic and non-romance languages.

9. *Methods of counting trichomonad flagellates.* ROBERT HEGNER.

In any investigation in which the results depend on the number of organisms present, a reliable method of counting is required. In several previous reports methods of counting trichomonad flagellates were described. These methods were satisfactory for the studies then in progress; but more recent investigations have demanded a more accurate enumeration. At first the organisms were described as very few, few, fair, good, abundant, etc.; then a loop-full of a certain size was confined under a cover-slip of a certain size and the number observed in the squares of a cross-ruled ocular disc recorded. Recently haemocytometers have come into use. This seems to be entirely satisfactory but a standardized haemocytometer must be used. An assistant and the writer counted the living trichomonads in well-mixed cultures, each using a separate haemocytometer and successive drops of culture medium. With one haemocytometer the average of 10 counts was 38 per cm. and with the other, 19 per cm. A second culture was then counted, each observer counting the number with each haemocytometer. In this case averages of 10 counts were 170 and 177 per cm. respectively with one haemocytometer and 334 and 335 per cm. with the other, demonstrating that the haemocytometers and not the observers were at fault.

10. *The use of the term "infectibility."* ROBERT HEGNER.

The word "infectibility," is not in the Century Dictionary, nor in Dorland's Medical Dictionary, but is a term that is easily understood and very useful in

describing the results of certain experiments. For example, the incidence of infection of a certain host by a certain parasite is really a measure of infectibility, whereas the severity of the infection indicates the host's susceptibility.

11. *GONGYLONEMA FILIFORME* Molin, 1857 not a synonym of *DIPETALONEMA GRACILE* (Diesing, 1861) Yorke and Maplestone, 1926. JOHN T. LUCKER.

In view of the extensive use of their book by nematologists attention is directed to the fact that Yorke and Maplestone (1926) regard *Gongylonema filiforme* as a synonym of *Dipetalonema gracile*. These authors have apparently uncritically accepted the synonymy of *G. filiforme*, *Filaria gracilis* Rudolphi, 1809 and *Dipetalonema caudispina* (Molin, 1858) Diesing, 1861, which Stossich published in 1897. Von Linstow (1899) also erroneously concluded that these three names are synonyms. The writer holds this synonymy to be untenable in so far as *G. filiforme* is concerned. There is no indication that either of these two early investigators subjected the type specimens of *G. filiforme* from *Simia inuus* to morphological study or that valid reasons exist for the inclusion of this species in the synonymy. Van Thiel (1926), on the contrary, has expressed the opinion that *G. filiforme* is a true *Gongylonema* and after careful study of the text, description and figures, published in 1857 by Molin, the writer concurs in this view.

In consequence of the synonymy referred to above the numerous primates from which *F. gracilis* and *D. caudispina* had been reported attained the status of hosts of *G. filiforme*. The withdrawal of *G. filiforme* from that synonymy obviously means that *Maccacus inuus* alone retains validity as a host of this species. This view appears to have been adopted by Stiles, Hassall and Nolan (1929), who list *M. inuus* as the only host of *G. filiforme*. It is difficult or impossible to determine from Molin's description, which is based only on female specimens, whether *G. filiforme* is distinct from other species of the genus; it is safe to conclude, however, that *M. inuus* is a valid host of *Gongylonema* sp. Recently, Galli-Valerio (1930) has reported *G. filiforme* from *Seige* sp. The manner in which this specific determination was reached is not indicated.

12. *Two new hosts of GONGYLONEMA PULCHRUM* Molin, 1857. JOHN T. LUCKER.

Several male and female specimens of *Gongylonema* collected from a spider monkey, *Ateles* sp., by H. W. Graybill, and deposited as U. S. N. M. Helm. Coll. No. 4454, and one male and two female specimens of the same genus from *Cebus capucinus* deposited as Dep't of Pathology, B. A. I. Collection No. 2226, have been studied by the writer in detail and identified as *G. pulchrum*. The only respect in which certain of the male specimens were found to differ from the morphological descriptions published for this species was the shortness of the left spicules. In seven males from *Ateles*, the length of the left spicule varies from 2.73 to 4.24 mm. Owing to the manner in which these specimens had been preserved it is quite probable that protruding portions of some of the spicules may have been broken off. The male from *Cebus capucinus* had been mounted in balsam, presumably at the time of its removal from the host. The left spicule is 2.52 mm. long. The two females from this host are 23.4 and 17.2 mm. long respectively, and the smaller one contains embryonated eggs. In view of the variation which has been recorded for the species, particularly in respect to size and spicule length, the identification of the specimens described above as *G. pulchrum* is warranted. It is suggested that dwarfed size may be due to the occurrence of the worm in an abnormal host.

13. *A second record of the occurrence of GONGYLONEMA in deer.* JOHN T. LUCKER.

Two female specimens of *Gongylonema* from a mule deer, *Odocoileus hemionis*, identified generically by the late Dr. B. H. Ransom, are found by the writer to

be indistinguishable from females of *G. pulchrum*, a species of common occurrence in domesticated ruminants and swine. The only previous records of *Gongylonema* in wild ruminants are those of Baylis (1925), who reported *G. pulchrum* from a chevrotain (*Tragulus sp.*), and Molin, who in 1857 reported a species of questioned validity, *G. spirale*, from a deer, *Cervus dama*.

14. Food reactions of *BALANTIDIUM COLI*. E. CLIFFORD NELSON.

In a series of experiments on the food reactions of *Balantidium coli* it has been possible to demonstrate that this ciliate ingests certain substances and rejects others. Starch grains are ingested with great avidity. In starch preparations 90 to 100 per cent of the Balantidia filled themselves to capacity within 15 minutes or less.

A series of experiments with powdered carbon, carmine, fullers' earth, and sulphur, the granules of which were about the same size as easily ingested starch granules, showed that only about 30 to 40 per cent of the ciliates in the preparations had ingested granules in one hour with no more than 2 or 3 very small granules in any one ciliate. However, carbon, carmine and fullers' earth that had been treated with dissolved starch was readily ingested by 95 to 100 per cent of the ciliates. Large quantities as well as the larger particles were ingested as actively as starch granules.

15. Some Morphological and Physiological Characters of the Mermithids in Their Relationship to Parasitism. G. STEINER.

For several years the Division of Nematology of the Bureau of Plant Industry has made extensive studies as to the economic significance of the mermithids as a controlling factor of insect pests, specifically grasshoppers. During these investigations much new information was also accumulated concerning the morphology and physiology of these nemas, particularly as related to the modifying influence of parasitism.

The so-called trophosome (fat body) of the mermithids is the homologue of a part of the intestine of other nematodes transformed into a storage organ for reserve material. Since all mermithids are body cavity parasites, they are at least partly immersed or surrounded by the blood of their hosts. This blood is their already "digested" food, consisting, chemically speaking, of simple "building stones" more or less directly assimilable by the tissues of the parasite. The mermithids therefore need no intestine for the decomposition, the "Abbau," or digestion of a chemically highly complex food into assimilable simple compounds. The one portion of the intestine adaptable for the storage of reserve material makes an enormous growth; the rest is either amputated in early larval life with the entire posterior larval body or excluded from growth and shed off at the last moult as a "larval caudal horn," or is apparently missing from the beginning. Some mermithids exhibit in early larval life an intestine like that found in all more typical nematode larvae. This intestine develops into a trophosome with an axial cavity (the homologue of the intestinal cavity!) and with a wall of polynucleate cells, the nuclei of which multiply by direct amitotic division. This is the most primitive type of a trophosome. In the next type the central cavity has disappeared and the trophosome represents a compact but cellular body. The third and most specialized type however is a compact but syncytial body.

In all mermithids an esophagus is present consisting of a cuticular tube sometimes even of body length. Attached to it are, in most instances, one to several bodies, sometimes of large size, consisting of single large cells or forming opaque or granular structures. At least three types of such bodies may be distinguished; stichocytes (*στίχος*—a row) often forming a stichosome, homocytes (*ὁμοπος*—neighboring) mostly large oval single cells, and epistomes, (*ἐπί*—to be fixed upon, *σῶμα*—body) bodies of various shape and fine granular or opaque structure. Nothing is known about the relationship of these

various types of cells and organs to each other or to structures in or around the oesophagus of more typical nemas. The three forms mentioned are possibly not the only ones. Their number, size, shape, structure and arrangement vary greatly. In some instances mermithid species are exceedingly similar except in regard to these structures. Various opinions have been expressed as to their significance and functions. They are said to be of excretory nature; another investigator views them as having to do with the "Abbau" of the trophosome and the change of its stored reserve material into the sexual products. It seems however that neither of these conceptions would account for the fact of their great diversity. Why should the "excretory" apparatus be so different in otherwise extremely similar species living in related hosts. These formations are undoubtedly at the height of their function during growth and impress the student by their reduced appearance in the adult stage, which seems to disprove any possible function in the transformation of the reserve material into sexual products. Their main function is during growth, especially in the early stages.

It is doubtful if the esophageal tube would be functionless and yet be preserved in all mermithids. Either this tube serves still as an inlet for fluid food, which however would be ineffective because of the absence of all "pumping" muscles, or it functions as an outlet or a distributor for secretions perhaps produced by the various bodies attached to it and mentioned above. Since our parasites live on their host's blood which is "digested" food, they might dispense with a digestive apparatus but not with organs which enable them to select from this "host digested" food the parts necessary for them or to transform these parts (proteins, etc.) so that they are assimilable by them. Perhaps the various organs and bodies attached to the esophagus of our mermithids function mainly in the assimilation of this foreign protein. The diversity of these organs therefore may be an expression of and an adaptation to, serologically speaking, the variety of blood fluids as available in the variety of hosts. Another fact of interest in this connection is the precedence the parasite takes in regard to the assimilation of food from the host blood over the very own tissues of the host, especially the gonads.

16. *The mother sporocyst of LECHRIORCHIS PRIMUS (Stafford). S. B. TALBOT.*

Comparatively few people have ever seen a living mother sporocyst and as far as I have been able to find, this stage has never been seen for any of the Plagiorchiidae. The present report concerns the mother sporocyst of *Lechriorchis primus* (Stafford, 1905). The egg of *L. primus* contains a fully developed miracidium when discharged from the trematode, but it will not hatch in the open. It must first be ingested by the snail, *Physella gyrina*, and be subjected to the action of the gastric juices of the snail's stomach before it will hatch. The miracidium actively penetrates the wall of the stomach and comes to lie along the digestive tract closely adherent to the surface without any appreciable migration. The earliest mother sporocysts to be studied was found one week after the snails had been exposed to the ova of the trematode. A selected sporocyst measured 62μ by 16μ a slight increase in size over the miracidium. The sporocyst wall is composed of a single layer of high cuboidal epithelium with the exception of the anterior end, where there are usually two to three layers of somewhat smaller cells. At this age the body cavity of the sporocyst is full of undifferentiated germ cells, showing a marked proliferation of these cells over the miracidium, which seldom contains more than four. The germ cells are quite large and contain a prominent nucleus and conspicuous nucleolus. They are readily distinguishable from the epithelial cells because of their large size and oval shape. At the end of two weeks, the mother sporocyst has increased in size to 0.61 mm. by 0.28 mm. and all the germ cells have formed germ balls. In the posterior end of the sporocyst, a few germ balls have dif-

ferentiated into young daughter sporocysts containing cercarial germ balls. The birth pore can be seen at this stage; it is terminal in position but is tightly closed. The mother sporocyst must elongate to accommodate the developing daughter sporocysts, consequently at the end of three weeks' development, it has become a somewhat irregular sac 1.7 mm. in length containing fully developed daughter sporocysts and many developing ones. The elongation of the mother sporocyst at this stage is probably not due to an increase in the number of epithelial cells, but rather that the high cuboidal epithelial cells of the early mother sporocyst have been stretched into a low squamosal type. This is actually what is seen when the epithelial cells of this stage are closely examined. Everywhere the cells are flat and in some regions lower than in others, thus producing the irregular contour of the body wall. The stress on the epithelial wall is conceivably not the same in all portions of the sporocyst since the young daughter sporocysts appear to develop in masses. The birth pore which in earlier stages was tightly closed, now is open and the channel leading into the body cavity is spread apart. The mother sporocyst at the end of three weeks has reached its maximum size as the first daughter sporocysts to mature have made their escape.

17. *A note on CYSTICERCUS OVIS.* PAUL C. UNDERWOOD.

Two lambs about one year of age that had been raised on the Animal Husbandry Experimental Farm at Beltsville, Md., were destroyed for necropsy. A generalized condition of cysticercosis was found. The cysts were identified macroscopically as *Cysticercus ovis*. In the first lamb examined, cysts were found rather evenly distributed in the muscular portion of the diaphragm, abdominal muscles, heart, and muscular coat of the esophagus. No cysts were found in the voluntary skeletal muscles of this animal. The second lamb examined carried a more extensive infestation which was most evident on the heart surface. The heart presented a distorted appearance, and numerous elevations of the pericardial surface due to the pressure of great numbers of cysts. The cysts were closely packed throughout the heart muscle as numerous incisions disclosed. Further evidence of the extent of the infestation was found in the muscles of the hind legs, which contained a great many more cysts. The muscular portion of the diaphragm, abdominal muscles, and the muscular coat of the esophagus were also heavily infested. In the cases of both animals the majority of the cysts were in good condition and to all appearances alive. Most of the degenerated cysts were in a caseous state, while a very few had become calcified. The infected tissue was fed to two dogs and six cats to note any development. One dog died two weeks after being fed the infected material, and the other dog was destroyed three months after being fed the same material. In neither case was there any evidence of *Taenia ovis*. The cats have not been destroyed but have given no indication of harboring *T. ovis*. Ransom reports that *Cysticercus ovis* is probably more or less generally distributed throughout the western United States, cases having been traced to points of origin in Montana, Idaho, Washington, Oregon, California, Colorado and Nevada, with no cases having been traced to eastern localities. If the host determination is correct, the findings in the present case would indicate a new area of distribution.

18. *A case of heavy ascarid infestation in a colt.* PAUL C. UNDERWOOD and EVERETT E. WEHR.

In the course of a post-mortem examination of a 6 months old colt, the writers encountered 404 ascarids, *Ascaris equorum*, mostly immature, and from 1 to 8 inches long. For a period of 3 months before the colt was killed it had been kept in a barn, so that it is clear that the infection was acquired in the barn, presumably from ascarid eggs eliminated from the intestine of the host animal. This observation emphasizes the need for stable sanitation and shows conclusively

that without due attention to this, parasitic infection is likely to occur whenever infective material is present.

19. *Further notes on the life history of GASTEROPHILUS INTESTINALIS.* E. E. WEHR.

Each of two colts, one three months and the other between 1 and 2 years old, was fed approximately 1600 newly-hatched larvae of *Gasterophilus intestinalis* over a period of 28 days, with 7 day intervals between feeding. Thirty-five days after the first feeding, each colt was killed and, in the course of the post-mortem examination, many larvae in the first instar were found embedded underneath the mucous membrane on the dorsal surface of the tongue, and several in the second instar were found attached to the mucous membrane of the fauces and stomach. The larvae present in the stomach represented distinctly two different stages of growth, and the larvae removed from the tongue represented distinctly three different stages of growth. It was concluded that the larvae introduced at the first and second feedings had reached the stomach; larvae of the last three feedings were still in the tongue, since the five sizes of larvae tallied with the five feedings. According to these experiments, it is quite obvious that the larvae of the first instar apparently require from 21 to 28 days to complete their development within the tongue of the host animal and get to the stomach. The primary object of these experiments was to determine the length of time the larvae remain in the tongue of the horse, and this time has been determined as probably not over, perhaps less than, 28 days. This information will be of value to the veterinarian as an aid in determining the right time to treat horses for bots in the fall. Treatment, of course, should not be begun until it is reasonably certain that all larvae have left the tongue and entered the stomach. Therefore, the date of treatment should be set at one month after the disappearance of the adult flies in the fall, providing it is reasonably certain that all the eggs on the horse hairs are dead. These eggs may be removed with a safety razor, or killed with a two per cent solution of cresol applied with a rag or mop.

A program for a bot control campaign should be set up as follows: After the first cold weather with a temperature of 32° F., or lower prevailing for a day or longer, remove or destroy the bot eggs on horses to be treated in the area of control; treat one month later.

20. *Occurrence of ASCARIDIA LINEATA in California Valley quail.* E. E. WEHR.

In the small intestine of a California Valley Quail cock, *Lophortyx californica*, which was sent to the Zoological Division by Dr. E. J. Moore, of Winston-Salem, South Carolina, for examination, there was found two specimens, a male and female, of *Ascaridia lineata*. This constitutes the first record of this parasite having been taken from this species of quail. The specimens appeared to be mature, although the male was only 17 mm. long and the female 30 mm. This bird was raised in captivity.

One Hundred and Fifty-first Meeting

The one hundred fifty-first meeting was held December 17, 1932, in the United States National Museum, Dr. E. W. Price presiding.

Dr. E. B. Cram transmitted to the Society the greetings of the newly formed Canadian Society of Parasitologists, as expressed in letters from Dr. Seymour Hadwen and Dr. A. M. Fallis, president and secretary-treasurer, respectively, of the Canadian Society. The new society has been formed after much the same plan as the Helminthological Society, the constitution adopted being practically the same as the membership policy of the Helminthological Society, and the Code of Ethics of the Helminthological Society having been adopted in its entirety.

Papers were presented as shown below.

L. A. SPINDLER, *Secretary.*

1. *The occurrence of STEPHANURUS DENTATUS in Northern United States.* J. E. ALICATA. H

In the United States the swine kidney worm is generally regarded as being limited to the South. Reports received in the Bureau of Animal Industry from time to time indicate that this parasite occurs in some of our Central and Northern States. The records of the Helminthological Collection of the U. S. National Museum show that *Stephanurus dentatus* has been reported from the following states outside the South: California, Connecticut, Illinois, Minnesota, Missouri, and New Jersey. It is of interest to note that all these reports, with the exception of those from Connecticut and Minnesota, show that *Stephanurus dentatus* has been found in localities below 40 degrees latitude. Of the two reports which show exceptions to this, one distribution record is from New Haven, Connecticut, and the other from Albert Lea, Minnesota, both places being located slightly north of 41 and 43 degrees latitude, respectively. The reports of the occurrence of this parasite in these two States do not indicate whether the infested hogs were raised locally.

Recently, Dr. J. Robinson, in charge of Federal meat inspection at Jacksonville, Illinois, forwarded to the bureau the liver, kidneys and perirenal fat of an old boar which had been raised in Morgan County, Illinois. This county is located slightly south of 40 degrees latitude. Twenty-eight adult *Stephanurus* were found encapsulated in the kidneys and kidney-fat of this hog; the liver showed the type of lesions usually associated with kidney-worm infestation in swine.

2. *A note on the genera PROTRELLUS Cobb, 1920, and PROTRELLINA Chitwood, 1932.* B. G. CHITWOOD. H

There now appears to be sufficient evidence that *Protrellina* and *Protrellus* are identical. Through the courtesy of Margaret V. Cobb I have had the opportunity to study the original manuscript upon which Dr. Cobb based the published description of *Protrellus*, type *P. aureus*. This manuscript is practically identical with the published description but in regard to the so-called lips he states, "There were apparently 6 lips but they were confluent . . . There was at least 1 papilla on each lip." This appears to indicate that there was some doubt in the author's mind as to the number of papillae. The heads of members of this group are not easily understood without the study of an en face view and since that was not the custom at the time of Dr. Cobb's original observations, the difference of cephalic papillae upon which *Protrellina* was based, is not explained. The species *Protrellina galebi*, *P. australasiae* and *P. kunkeli* should now be replaced in the genus *Protrellus*, and *Protrellina aurifluus* and *P. manni* placed in that genus, the combinations being *Protrellus aurifluus* (Chitwood, 1932) n. comb., and *Protrellus manni* (Chitwood, 1932) n. comb. Of the species then in the genus *Protrellus*, *P. aureus* is closest to *P. kunkeli* and *P. aurifluus* but differs from the first in that the oesophagus is shorter and the eggs smaller in *P. aureus* and from the second in that the oesophagus is longer and the eggs larger.

3. *A note on the status of VESTIBULOSETARIA Vogel and Gabaldon, 1932.* B. G. CHITWOOD. H

The genus *Vestibulosestaria* was erected by Vogel and Gabaldon, 1932, for *V. patersoni* (Mazza, 1928), syn., *Filaria patersoni* Mazza, 1928. This genus appears to be a synonym of *Litomosoides* Chandler, 1932, and the type species appears to be identical with *L. sigmodontis* Chandler, 1931. The name for this nematode should therefore be *Litomosoides patersoni* (Mazza, 1928).

4. *A note on the systematic position of CRUZNEMA CRUZNEMA Atrigas, 1927.* B. G. CHITWOOD. H

This nematode which was described as a parasite of millipeds appears to be a synonym of *Rhabditis lambdiensis* Maupas, 1919, and not an oxyurid as has been supposed.

5. Comparative data relative to incidence of worm parasites in confined and non-confined chickens. E. CUVILLIER and M. F. JONES.

In an attempt to secure data on the relation between confinement and the incidence of parasitism in chickens, three groups of chickens were examined post-mortem at the experimental farm at Beltsville, Maryland. Group I consisted of 40 birds which had been raised with access to unscreened cement runs and confined as adults on the second floor of unscreened wooden houses. Group II consisted of 40 birds, raised on range and confined as adults under conditions similar to those of group I, except that they were kept on the first floor. Group III consisted of 36 birds raised on free range throughout life. All groups were about 18 months old when killed.

Of group I (confined throughout life) 30 out of 40 birds, or 75 per cent, were entirely free from parasites. Only one bird showed a considerable number of parasites, having 37 specimens of *Choanotaenia infundibulum*. The nine other parasitized birds harbored *Ascaridia lineata*, *Heterakis gallinae*, or *C. infundibulum*, in very small numbers. It is of interest to note the occurrence of *C. infundibulum* in this group, since the chief intermediate host of the species is the house fly.

Of group II (confined only as adults) only 2 birds, or 5 per cent, were free from parasites. Of group III (allowed free range throughout life) only a single bird, or 2.8 per cent, was free from parasites. The parasites present in groups II and III may be compared as follows:

Heterakis gallinae: An average of twice as many worms per bird (72) were present in the free range as in the partially confined group. All birds not entirely free of parasites contained worms of this species in these groups.

Ascaridia lineata: An average of 3 times as many (4) worms per bird were present in the free range groups as in the partially confined group. Of the range group, 15 were parasitized; of the partially confined, 13 were parasitized.

Raillietina cesticillus: An average of 1.6 worms per bird in partially confined group, and 4 worms per bird in range group. Of the former group, 7 were parasitized; of latter group, 8 were parasitized.

Raillietina sp.: Average of 0.5 worms per bird in partially confined group, 1.5 worms per bird in range groups. Of the former group, 11 were parasitized; of the range group, 15 were parasitized.

Hymenolepis carioca: Average number of worms per bird not known. Of partially confined group, 5 birds were parasitized, 10 specimens in 1 bird and "few" in each of others. Of free range group, 7 birds were parasitized, 40 specimens in 2 birds, 15 in 1 and "few" in 4 birds.

Hymenolepis sp. and *H. cantaniana*: Average number of worms per bird not known. Of partially confined group, "few" specimens present in 1 bird. Of range group, 50, 30, "few" and "few," respectively, present in 4 birds.

Capillaria annulata: Of partially confined group, present in 1 bird. Of range group, present in 8 birds.

Capillaria sp., of intestine: Of partially confined group, present in 3 birds. Of range group, present in 5 birds.

Capillaria sp., of ceca: Not present in partially confined group. Of range group, present in 7 birds.

To summarize, in each case there was not only a great number of worms per bird in the free range group, but a greater number of birds was parasitized. The degree of parasitism in only partially confined or non-confined birds is thus shown to be much higher than in birds which had been confined during life, as regards number of birds parasitized, number of species of parasites represented, and numbers of individuals of parasites present. In conclusion, the fact that 75 per cent of the totally confined birds remained entirely free from worm parasites, while only 2 per cent or 5 per cent of the other groups were parasite-free, is considered significant.

6. *On the systematic position of DAVAINA FUHRMANNI* Williams, 1931. M. F. JONES. + 4

Railiitina silvestris Jones, 1933 is proposed as a new name for *Davainia fuhrmanni* Williams, 1931, a homonym of *Davainia fuhrmanni* Southwell, 1922. Dr. Williams suggested that the writer re-name the species, after the matter had been brought to his attention.

7. *An observation on the significance of climatic factors in the development of an infestation in Narcissus by the bulb nematode (TYLENCHUS DIPSACI Kuhn).* G. STEINER. + 4

A commercial bulb grower recently acquired from a firm near Richmond, Virginia, a quantity of narcissus bulbs apparently free from the bulb nematode *Tylenchus dipsaci*. These bulbs were replanted near Chesapeake Beach in moist land, and, because of their apparent soundness and the absence of ring symptoms, were submitted only partly to a hot-water treatment as applied for the control of the aforementioned nema. However, the following season, although planted on land that had never grown narcissus, these untreated bulbs were badly attacked by the bulb nema and almost a complete loss. A careful examination of the original planting near Richmond revealed the following situation: This stock was grass grown, the planting was situated high and dry and well exposed to the sun, the soil a light sandy loam. A number of varieties were grown; some had not been moved for 15 years. All varieties developed only small bulbs, and the flowers were used for the cut flower market. Twice, additional stock was bought; forced imported stock from Philadelphia in pre-Quarantine time, and stock from Bellingham, Washington. In the fall of 1932 all varieties were tested for the presence of *Tylenchus dipsaci*, which was found in all of them, but mostly in small numbers. In only one instance were ring symptoms observed. All nemic specimens were small, of decidedly dwarfed appearance and were mostly found on the surface of the otherwise hard bulbs.

Without doubt the dry and hot conditions of the location kept down the *Tylenchus dipsaci* infestation in the original planting. However, the removal of these bulbs to a location with more optimal conditions for the bulb as well as the parasite resulted in a sudden virulent outbreak of the disease. That *Tylenchus dipsaci* depends much upon moderate heat is a well known fact, but the present case is an excellent illustration of the practical importance of such conditions.

8. *CEPHALOBUS ELONGATUS* De Man. *Parasitizing PRIMULA POLYANTHA and observations on its reviviscence.* G. STEINER. + 4

Through Dr. G. P. Clinton of the Connecticut Agricultural Experiment Station, New Haven, leaves of a *Primula polyantha* were received. These leaves had been collected August 10, 1932 in Orange, Connecticut from diseased plants. They exhibited white spots which proved to harbor the nema *Cephalobus elongatus* De Man. As a pathogen this nematode is of somewhat doubtful standing. It is of world-wide distribution, found living free and saprophytic or saprozoic, but often also observed in diseased plants where it may be associated with or follow another primary agent. However it is known that this *Cephalobus* itself can act as a primary parasite, taking advantage of weakened conditions of a plant. The present case seems to be one of true parasitism. The white leaf-spots apparently produced by it are surrounded by areas of yellowish discoloration.

Earlier observations have demonstrated the ability of *Cephalobus elongatus* to pass into a dormant stage and revive. The present material confirmed this. Large numbers of specimens from these primula leaves revived after a dormancy period of 3 months and 10 days. On December 21 a special test was made to ascertain what developmental stages of the nema would revive and after what

length of time of soaking. The following table gives the results of this experiment, which began by soaking parts of a leaf at 9:00 A. M. and ended 24 hours later.

Time of revival after soaking	Number and age of revived specimens						Totals
	First stage larva	Second stage larva	Third stage larva	Fourth stage larva	♂	♀	
1 hour	1				1		2
1 " 40 min.		1			2	1	4
2 hours		1		1 (♀)	2	3	7
2 " 40 min.		1		1 (♂) 1 (♀)		1	4
4 " 40 min.					7	2	9
5 " 40 min.	1	2	1	1 (♂)	3	1	9
6 " 30 min.					1	1	2
24 "		2	2	1 (♀)	2		7
Totals	2	7	3	5	18	9	44

It may be that the first stage larvae hatched from eggs while soaking. The revived adult males and females were all of the youngest age, the females seemingly unfertilized and without eggs in the uterus. Older adult specimens did not revive.

The present observations therefore prove that in *Cephalobus elongatus* all larval stages may revive after a dormancy of over three months. Since the adults were not seen to be moulting it is believed that the young adult stage will also revive.